PEARL

The Journal of HEREDITY

A PEDIGREE CHART OF FOOT SHAPE

(SEE PAGE 329)

Heredity and Blindness — *Origins of Business Leaders*

Inheritance of Cryptorchidism in Swine

"Woolly" Cacti — *13-Chromosome Cottons*

Pedigrees of the Socially Inadequate

A Dwarf Four O'Clock — *Value of Twin Research*

A Fake Pedigree of Eye Defect

VOLUME 25 AUGUST, 1934 NUMBER 8

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An incorporated organization devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks

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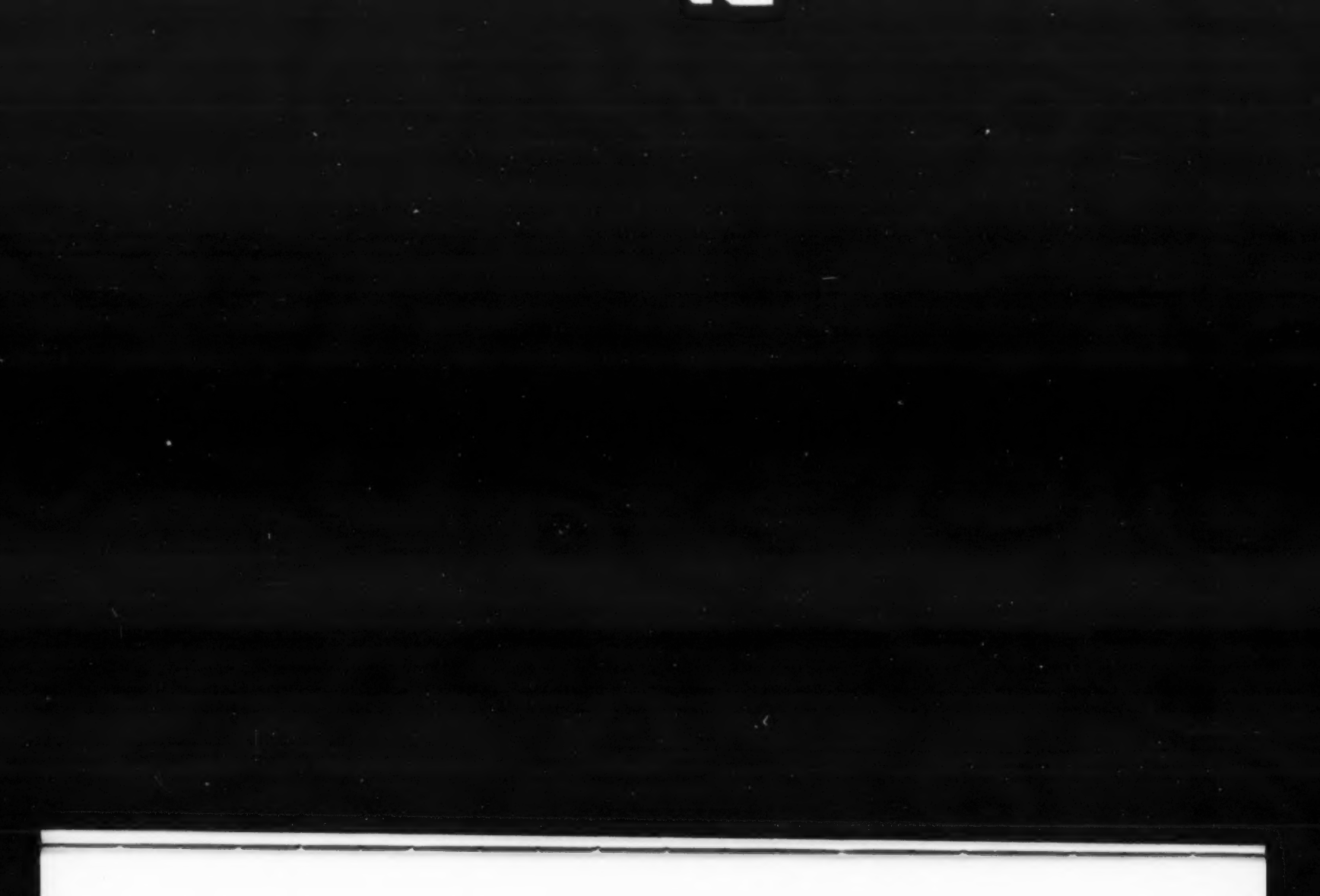

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COMING

Eighteenth Century Families

A novel approach to the problem of family size before census and questionnaire statistics were as voluminous as they are today.

Semi-Hairless Cattle

Inherited deficiency in hair development, apparently associated with mental characteristics and with survival.

Two Types of Polydactylous Guinea Pigs

Very different types conditioned by the same gene—heterozygotes being "super-normals" and homozygotes, monsters.

An Inherited Tremor in Poultry

A gene (or genes) which affects only young chicks, though possibly with other manifestations later in the life cycle.

Another "Woolly" Mutation in Man

Spontaneous appearance of frizzled hair in a Dutch family with no evidence of race crossing. Illustrated with three generation photographic pedigree charts.

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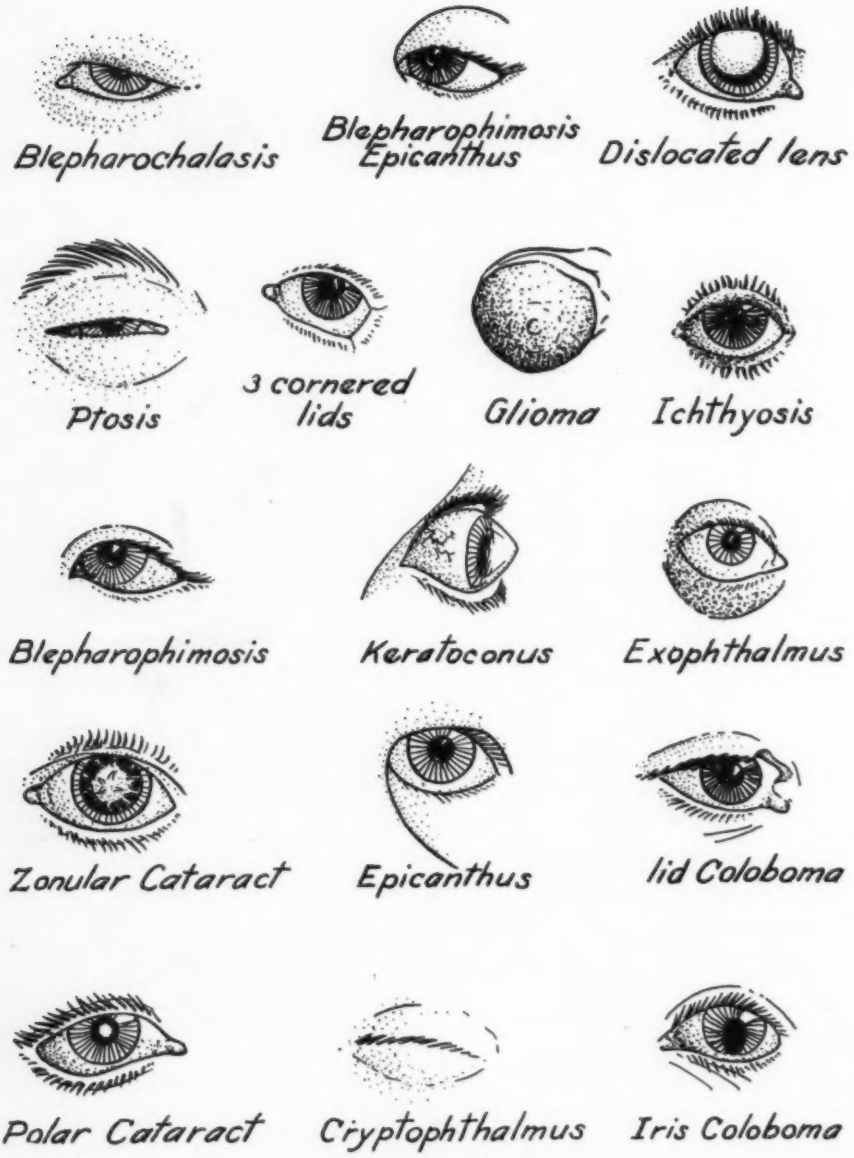


INHERITED EYE DEFECTS

Frontispiece

Pen and ink drawings of a few eye defects known to be hereditary, (sketched from illustrations in Waardenburg's "Das Menschliche Auge"). The proportion of blindness due to hereditary causes is not exactly known. Minimum estimates place the proportion of all blindness due to heredity at eleven per cent. Were complete information available this figure would in all likelihood have to be very considerably increased.

HEREDITY AS A CAUSE OF HUMAN BLINDNESS

A Review

CLYDE E. KEELER

Section on Heredity, Howe Laboratory, Harvard Medical School

THE world-wide economic depression, the universal wave of crime, intensified nationalism, development of eugenics, and many other factors have combined at this time as never before to compel nations to face the problems of individual physical and mental handicap. Studies and surveys of criminality, insanity, deafness, blindness and other anomalies are receiving unheard-of-attention. Classics are being written in all these fields.

Hitler has decreed for the purification of German stocks so far as is possible by the sterilization of all persons known by the hereditary nature of their physical deformities to bear defective germ plasm. The subject is receiving attention in England. The Eugenics Research Association meeting this year was devoted principally to Race Integrity.

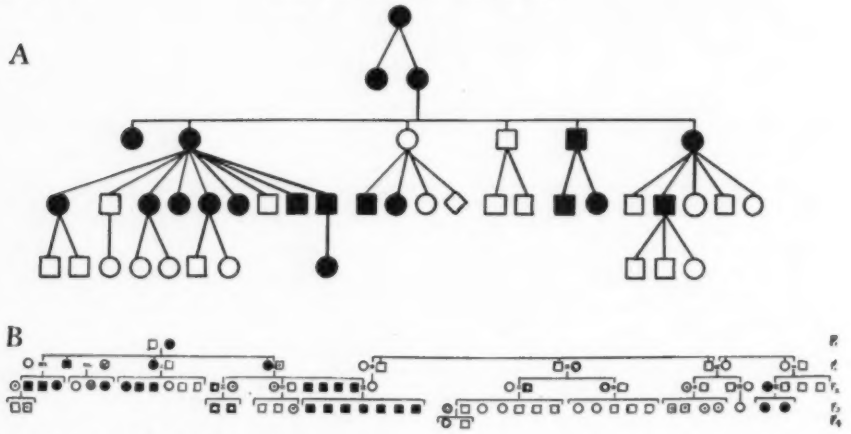
The most striking fact about the whole race-purification movement is the preponderant rôle which heredity plays in the production of all these physical and mental deformities which it is hoped may be eliminated. The radical says that the movement is timely; the conservative avers that we lack sufficient information about the nature of these handicaps upon which to base valid conclusions. But whether timely or premature the race-purification movement is upon us.

Blindness in America presents a peculiar problem. Here "Prevention of Blindness" has been for many years the slogan of much worthy propaganda, but thus far these efforts have failed to take cognizance of the enormous hereditary factor involved. It is true that in many individual cases it is impossible to differentiate between the defects produced by disease, faulty development, or heredity. This calls for intensive ophthalmological study and a sharpening of our diagnoses. It calls for investigations of individual pedigrees.

Information Inadequate

Our examination of institutional files reveals that while a few institutions maintain splendid records, the majority of them are in a very unsatisfactory condition and that conclusions based upon these records are inaccurate. Even where accurate diagnoses are made and records are perfectly kept, the deliberate falsehoods entered upon the records by relatives of the inmates destroy much of their value. The records of one State School for the Blind which we have examined show that a mother wrote upon the separate admission questionnaires for each of her four blind children that no person in the family save the applicant had ever been blind. She had a fifth blind child at home still under school age.

Our questionnaires sent to the various states show that the records kept of state and county expenditures for schools, sight-saving classes, aids, readers, printing, pensions, etc., are insufficient to evaluate accurately the many items necessary for computing the cost of blindness. The best statistics we may hope for are inaccurate estimates. With these almost insurmountable difficulties in mind, great credit is due to Dr. Harry Best for his brave attempt to collect statistics upon blindness.


A
B
Blue with narrow, colored iris margin.
Blue with light coloring matter about the periphery.
Scattered pigment, especially a corona about the pupil in light eyes.
Simplex (blue or gray).
Dark brown (not completely diffuse).
Scattered spots in lighter eyes.

INHERITANCE OF PIGMENTATION OF THE EYE

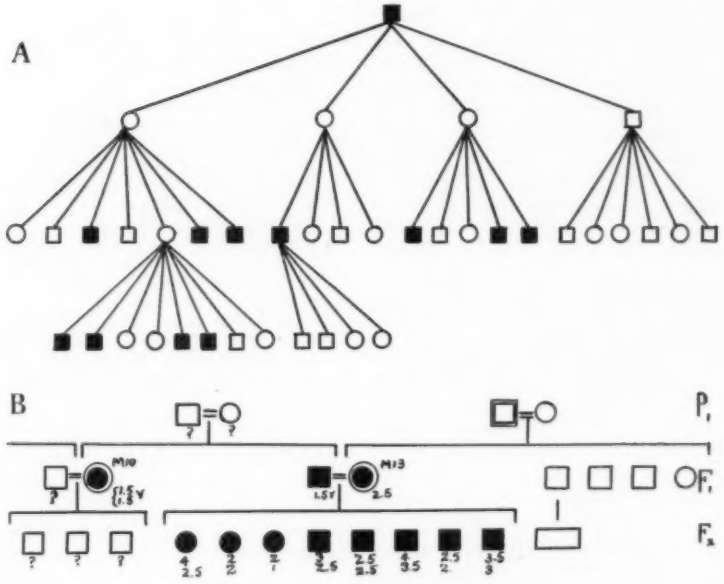
Figure 1

Pigmentation of various parts of the eye is a matter of vital importance to its proper function. The absence of pigment, as in true albinism, results in serious limitation of vision. The distribution of pigment in and around the eye is largely controlled by heredity. At (*A*) is given the pedigree of a family (after R. Peters) showing the inheritance for five generations of dark eyelids. At (*B*) is given a pedigree showing the inheritance of iris color for four generations, showing the tendency toward dominance of more intense pigmentation. From "Das Meñschliche Auge."

Fifty-five chapters compose his recent volume on the subject.* The titles of some representative chapters are: Causes of Blindness and Extent of its Possible Prevention; Blindness and Heredity, Blindness and Disease; Blindness and Accidents; Organized Measures for Prevention of Blindness; The Blind by Sex, Age, Race, Nativity; Physical and Mental Condition of Blind; Education; Economic Condition; Cost of Blindness.

We are particularly interested in what Dr. Best has to say about heredity. "The proportion of the blind with blind relatives who have blind parents in the aggregate (alone or in combination with other relatives) is 33.3 per cent; who have blind brothers or sisters in the aggregate, 71.2 per cent; and who have blind children in the aggregate, 6.1 per cent. The proportion with blind relatives who have blind parents alone is 24.1 per cent; who have blind brothers or sisters alone, 61.4 per cent; and who have blind children alone, 4.2 per cent. The proportion having one parent blind is 32.3 per cent, and that having both parents blind, 1.0 per cent. . . . The proportion who have both blind parents and blind brothers or sisters is 8.7 per cent." Best estimates 11.0 per cent of all blindness to be due to heredity! "Of those blind persons having a parent blind, practically three-tenths (31.3 per cent) have in addition brothers or sisters who are blind. This proportion is almost four times as great as the corresponding proportion for those not having a blind parent but having blind brothers or sisters (8.8 per cent)." We may suggest

*Best, Harry. *Blindness and the Blind in the United States.* Price $6.50. The Macmillan Company. New York, 1934.



CORNEAL DEFECTS INHERITED

Figure 2

(*A*) is a pedigree showing recessive sex-linked inheritance of keratosis follicularis, a form of degeneration of the cornea. Note that affected males transmit the character to their grandsons through their daughters (who themselves do not show the defect). The sons of affected males neither have the disease nor transmit it. Below at (*B*) is shown a pedigree of corneal astigmatism. The degree of astigmatism is shown under the symbols in diopters, which give a numerical expression of the extent to which the eye tends to be a cylinder rather than a sphere. Astigmatism may also be due to defects in the lens or to unequal muscular contraction.

that this difference is probably due in a large measure to dominant defects in the first case and recessive defects in the second. Dr. Best mentions Dr. Loeb's 1909 study. "In all the families in which blindness of hereditary character is recorded of the children born 60.7 per cent are blind. . . . In families where heredity is collateral—through cousins, or uncles or aunts—66.4 per cent of children are blind." We may suggest that many of these latter cases represent families where the parents are normal overlaps.

Best lists defects having hereditary tendencies as progressive myopia, retinitis pigmentosa, detachment of the retina, cataract, glaucoma, old age, trachoma, neuralgia, exposure to heat and sore eyes. He quotes Loeb's list which adds albinism, aniridia and coloboma iridis, anophthalmus, microphthalmus, atrophy of the optic nerve, ectopia lentis, familial corneal degeneration, megalophthalmus, nystagmus, ophthalmophlegia and ptosis (including strabismus). To these Best again adds others less common which may have hereditary influences: optic neuritis, macular and other retinal degeneration; nodular and reticular opacities of the cornea; syphilis in the form of interstitial keratitis; retinitis punctata albescens; distichiasis; buphthalmus; certain forms of choroiditis, certain forms of iritis; certain forms of glioma;

certain forms of amertropia; amaurosis from certain types of degeneration; blindness from idiocy; myopia and astigmatism. "Of the blind having parents who are first cousins, 37.5 per cent have blind relatives, as compared with 11.0 per cent for the blind in general." In respect to the value of eugenics to problems of blindness Best says: "So far as the increased possibility of blindness resulting from the marriage of blind persons is concerned, there is little need to fear, purely from the standpoint of eugenics, that the amount thereof will prove considerable. This is true even with respect to the marriage of the blind with the blind, though on other grounds strong objections are to be advanced to such unions." Evidently, Best sees the matter from the standpoint of increasing the number of hereditary blind over and above the number now existing, rather than from the standpoint of reducing as much as possible the present number of hereditary blind. Most geneticists will disagree with some of the views expressed in this chapter. The remaining chapters are filled with facts of paramount importance to the sociologist and worker for the blind. A great range of literature is cited. Even though we may not concur with Best's opinions upon heredity, we must admit that in its specialized field this volume will long stand alone.

The Genetics of Eye Defects

The hereditary types of defect producing blindness which Best shows to constitute at least 11.0 per cent of all blindness are admirably treated by Waardenburg in his 631 page volume, listing more than 120 types of hereditary ocular variation, and illustrated with 8 colored plates and 197 text-figures.* A sample of the completeness of this work is his treatment of the subject of albinism. Whereas most geneticists distinguish but one or two types of albinism, Waardenburg divides pigment variations into the following classes:

1. Complete albinism.
2. Incomplete albinism.
3. Localized eye and fundus albinism.
4. Aplasia, especially hypoplasia of the macula lutea.
5. Aplasia, especially hypoplasia of the macula and other portions of the retina with night blindness, restriction of visual field and strong secondary nystagmus.
6. Nystagmus with high grade myopia, and weak sight without weakening of the macula and albinism.
7. Primary nystagmus without underdevelopment of macula, without albinism or albinoid tendencies (irregular dominant).
8. Primary nystagmus without ocular indications (recessive).
9. Primary nystagmus without ocular indications (recessive-sex-linked).

The first chapter consists of an introduction, the second deals with pigment variation. The third takes up the lids and clefts describing variations in lashes, lid-folds, position, form and size of clefts, variations in conjunctiva and coloration of the lids. The inheritance of the latter is illustrated by a pedigree from R. Peters which we include as Figure 1*A*.

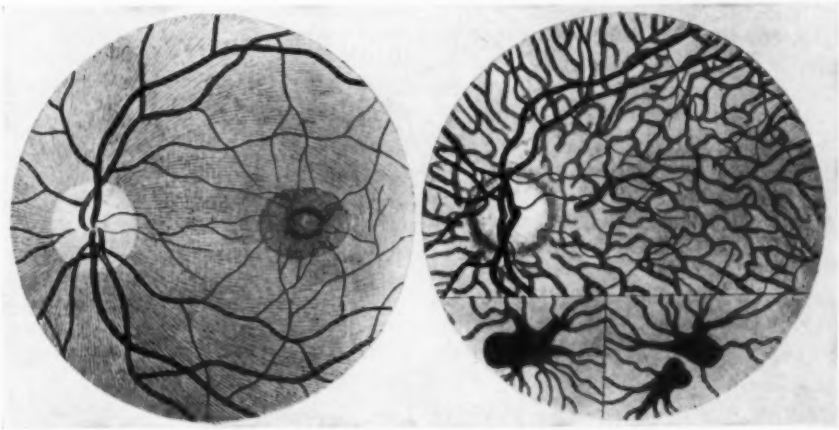
Under orbital variations are considered those of race and sex, individual variations, orbit and cleft, Dysostosis craniofacialis, dome heads, Dysostosis cleido-cranialis, exophthalmus, and facial asymmetry.

Waardenburg includes in the chapter on tear apparatus the tear glands, puncta, tear ducts, sac and naso-lacrimal ducts.

The subjects of ptosis, opththalmoplegia, paralysis, and abnormal movements of the lids are included in the chapter upon muscles.

The discussion of the cornea includes such interesting subjects as corneal astigmatism, keratocornus, corneal thickness, flat cornea, microcornea, cryptophthalmus, corneal degeneration and corneal pigmentation. In Figure 2*B* is shown a pedigree of astigmatism from Waardenburg and in Figure 2*A* one of corneal degenera-

*Waardenburg, P. J. *Das Menschliche Auge und seine Erbanlagen.* Price 30 gilders. Martinus Nijhoff, The Hague, 1932.



RETINA OF NORMAL AND ALBINO EYES

Figure 3

At the left is shown an enlarged view of the retina of a normal eye showing the region of the fundus and the veins and arteries which supply the retina. At the right is the same region of an albino eye. Note the remarkable system of blood vessels which radiate from the fundus of the albino eye which are invisible in the normal. From Waardenburg, *Das Menschliche Auge.*

tion from Waardenburg after Laméris-Rochat.

The variations of the sclera include the interesting subject of blue sclerotics. These individuals display a number of curious defects in addition to the blue eyeball,—brittle bones, deafness, thin sclera, degeneration of Bowman's and Decemet's membranes, oedema of the sclera, stunted growth, late teething and brittle teeth.

Hereditary vascular variations are many and include persistent pupillary membranes, size and form of pupil, ectopia pupillae, normal pigmentation, heterochromia, hypo- and hyper-pigmentations. Iris structure, hyperplasia of the iris layers, underdevelopment of iris muscles, multiple pupils, aniridia, coloboma of the iris, etc., are also discussed. In Figure 1*B* is shown a pedigree of eye color from Waardenburg.

The manifold forms of cataract are dealt with under the subject of lens as well as absence and underdevelopment of the lens, ectopia lentis, dislocation of the lens and correlated anomalies.

Short chapters consider the vitreous, zonule and pressure phenomena such as hydrophthalmus and glaucoma. A huge chapter covers variations of the optic nerve and the retina. Here one finds much information upon coloboma of the macula, hypoplasia and aplasia of the fovea and macula, total colorblindness, progressive degeneration of the macula, amaurotic family idiocy and night blindness. Also retinitis pigmentatosa, and other retinal degenerations, retinal tumors, atrophy of the optic nerve, and coloboma of the optic nerve are discussed.

The general topic of correlations between eye defects and those of the nervous system is considered under such topics as cerebro-spinal ataxia, migraine, progressive muscular atrophy, word blindness and the like.

There is a chapter on the heredity of refraction phenomena which deals with such topics as far sightedness and near sightedness; another dealing with general variability, asymmetry, and individual ocular characters. Another chapter has to do with hereditary ocular variations as manifest from the study of identical twins, while another considers the vision

of children born to related parents. The last chapter consists of a conclusion which is followed by comprehensive author and subject indices.

The nature of the colored illustrations but not their fine quality is indicated by the accompanying plates (reproduced in Figure 3) from the chapters on albinism. The rich variety of hereditary ocular variations dealt with we suggest with a series of pen drawings sketched from actual photos in Waardenburg's book (Frontispiece). Unfortunately, several halftones are printed too dark to be of much value, and the photographs of most patients are of a size too small to illustrate their defects satisfactorily for those not already familiar with them. The reader will note but probably not be confused by the several methods employed in the preparation of pedigree charts. There is an enormous bibliography.

No institution or individual interested in the subject of human blindness from any angle whatsoever can afford to be without these two classics.

The Value of Twin Research

To the Editor of The Journal of Heredity:

This letter is in response to the solicitation of opinion contained in Prof. H. H. Newman's article on identical twins reared apart which appeared in the April, 1934, issue of the JOURNAL OF HEREDITY.

To Prof. Newman's question as to whether interest in such studies of identical twins reared apart, as he has made, is such as to warrant a continuation of his program, the answer, in my opinion, is unquestionably yes.

Not only he, but any other competent observer should put on record in the literature all cases of that kind which may come to attention and be accessible to investigation.

I believe it to be necessary to accumulate an amount of such material which would be sufficient for statistical treatment: at least one hundred cases.

I have a further suggestion to offer, namely, that a similar number of cases of identical twins reared together be investigated by precisely the same technique for use as control material. On the basis of observation of such cases in my own collection, I feel certain that such differences as have been found by Prof. Newman between identical twins reared apart are also to be found between identical twins reared together, though, perhaps, not with the same frequency.

In such cases it is often possible to demonstrate that the differences are due not to external environmental factors but partly to differences in intrauterine conditions or to factors at work at the time of birth.

It seems to me that only a comparison of the statistical findings of the group studied with those of a control group, selected as above, would make possible a definite conclusion as to the precise parts played, respectively, by germinal, intrauterine, natal, and postnatal factors on intelligence and other measurable traits.

For added control, from another angle, I believe there would be considerable advantage to be gained from an investigation, by the same technique, of a group of same-sex fraternal twins reared together.

Inasmuch as there is strong evidence to indicate that there are sex differences in intrauterine, infant, and early childhood mortality, in the vulnerability of cerebral tissues; and, as a result, in the incidence of both relative and absolute mental deficiency and other conditions definitely attributable to birth trauma, the materials gathered should be scrutinized in such a way as to reveal the findings separately for the two sexes.

AARON J. ROSANOFF

Los Angeles, Calif.

INHERITANCE OF CRYPTORCHIDISM IN SWINE

HUGH C. MCPHEE and S. S. BUCKLEY*
Bureau of Animal Industry, U. S. Department of Agriculture

CRYPTORCHIDISM is the condition which results from the failure of one or both testicles to descend into the scrotum. When both testicles are retained within the abdominal cavity the animal is called a bilateral cryptorchid in contrast to the unilateral or monorchid condition where only one of the testicles fails to descend. The condition occurs among all farm animals but probably not with equal frequency. It appears to be more common among horses and swine than among cattle, sheep and goats. It is a defect which has been discriminated against by breeders and judges of purebred livestock for a long time. The principal reason for such discrimination is, of course, the widespread belief that there exists an association between cryptorchidism and sterility.

Material

The present report deals with the occurrence of cryptorchidism in an inbred strain of Chester White swine which was developed at the U. S. Animal Husbandry Experiment Farm, Beltsville, Maryland. This strain was being developed by continuous brother × sister mating accompanied by selection for the purpose of establishing a group which would breed true for as many desirable characteristics as possible. It is easy to understand that such an objective is somewhat antagonistic to studies on the inheritance of characters which are considered distinct defects. Although the data presented in this report make possible a little more progress in the unraveling of the genetic basis of cryptorchidism of swine, admittedly they fall far short of furnishing material for a complete analysis. The evidence really concerns the success with which characters of this kind may be eliminated by close breeding and selection.

The selection of breeding stock in each generation of inbreeding was based on size of litter, growth rate, conformation and general breed characteristics. Obviously when so many things are concerned and the number of individuals is limited many compromises must be made. The great difficulty which was encountered in finding matings which would continue under a system of brother × sister mating resulted in the alternative either of being lenient or of discarding the entire line. Many times it became necessary to select stock for breeding from litters containing a cryptorchid merely because they were the best pigs available and gave the greatest promise of propagating the line. If this had not been done the writer is of the opinion that it would have been impossible to have continued the strain which has now reached six generations of continuous brother × sister mating and has retained to a remarkable degree, fecundity, rate and economy of gain and desirable conformation.

The parent stock of the inbred strain consisted of four litter mates, three sows and one boar from registered Chester White parents. One of these sows produced only one litter from which no selections were made, therefore the parent stock really consisted of only three litter mates. There was no record of any cryptorchids in the ancestry of these pigs. The dam of the three foundation ani-

*Deceased.

mals farrowed a total of 28 boar pigs, all of which were normal in appearance.

The first indication that the strain carried the defect was given by the appearance of a double cryptorchid boar pig in the first inbred generation. The sex distribution in this generation was 24 males and 29 females. If there had been more certainty at that time concerning the hereditary basis of the character serious consideration might have been given to the elimination of the strain from further consideration. In view of the absence of definite information, however, and also because of the fact that the pigs gave strong indications of making possible the establishment of an inbred strain after many unsuccessful attempts, it was decided to continue. The results obtained in subsequent generations are described below.

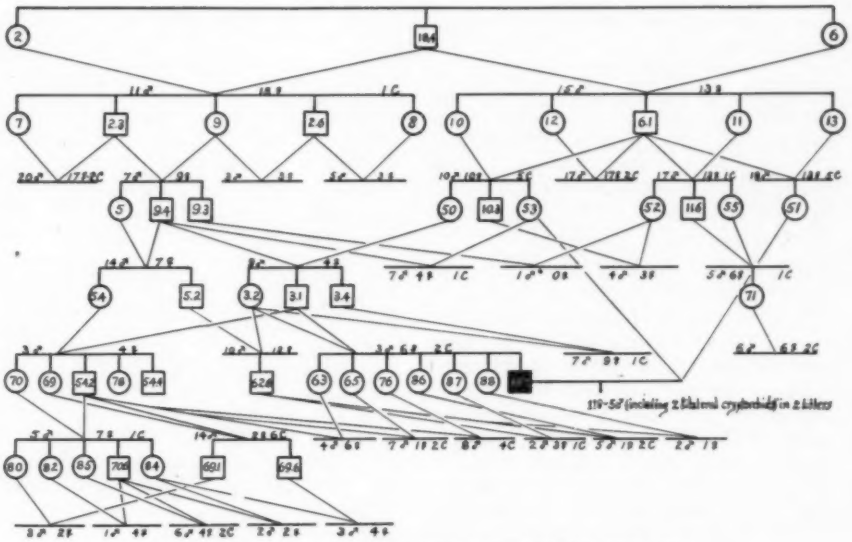
The literature dealing with cryptorchidism in swine recently has been brought up to date by Nordby[5] in a report which deals particularly with its economic importance to the producer of swine. In this paper are discussed the various aspects of the subject including prevalence, sexual development, quality of meat, castration, anatomy, histological structure and inheritance. In common with several other writers on the subject, Nordby concludes that the condition is probably hereditary but information is too fragmentary for the working out of details. The above paper contains a bibliography of twenty citations to which the reader is referred for further references.

Inheritance

The hereditary basis of cryptorchidism has scarcely been mentioned in the literature. Lush, Jones and Dameron[2] found that many cases of cryptorchidism in the goat have a hereditary basis but they were unable to determine the exact details of inheritance. Likewise Hadley and Warwick[1] state that the condition probably has a hereditary basis but experimental proof is lacking. McKenzie[4] reports a case where a sire who had ten cryptorchid sons to his credit was mated to one of his daughters from a litter containing a cryptorchid son. A litter of six, of which two were cryptorchids, was obtained. Since approximately half of the male progeny were cryptorchids McKenzie concludes that the condition probably is inherited. Nordby does not give any new experimental evidence but concludes that cryptorchidism is inherited and advises the elimination of all parents which produce litters containing cryptorchids.

Before examining the evidence concerning the hereditary basis of cryptorchidism presented in this report, the writer wishes to mention some important points concerning the nature of the character under discussion. Regardless of what the exact genetic details may later prove to be, the condition, must be regarded as strictly sex limited since it can be developed only by males. Furthermore, the evidence already reported by others shows that recessive genes are involved. A third point which is of very great importance not only to the breeder but to the investigator is the fact that cryptorchidism is associated with sterility. This is particularly true of the bilateral cryptorchid.

Probably these difficulties have been to a large extent responsible for the lack of information on the genetic basis. Boars which appear normal can transmit the genes to their offspring. Hence, normal appearing boars are either heterozygous for or free from the recessive genes. Sows may be either homozygous or heterozygous for the genes or entirely free from them, i. e. homozygous normals. There is no way to separate the three classes except by breeding tests with boars of known genetic constitution relative to this character. The fact that only normal appearing



PEDIGREE OF CRYPTORCHID-BEARING STRAIN

Figure 4

Pedigree of inbred strain of Chester White pigs, showing the breeding animals in each generation. Not all litters farrowed could be shown because of limited space. Further details of all litters concerned in the cryptorchid data are given in Table I. The numerals in the squares and circles are the herd numbers of the boars and sows respectively. The fertile cryptorchid (62.7) mated to two related sows, produced two litters totalling 16 pigs. One bilateral cryptorchid was obtained in each litter.

boars are usually selected for breeding is doubtless responsible for a widespread dissemination of the genes among the swine population of the country. Because of the nature of the character it might be some time before there occurred the type of mating required to bring about effective combinations for the expression of the character.

For the purpose of discussing the results from the various matings listed in Table I and shown graphically in Figure 4 it is assumed that cryptorchidism is due primarily to the action of a single gene. It is further assumed that both bilateral and unilateral cryptorchids have the same general genetic constitution. Then if these assumptions are true all of the boars except 140.6 and 62.7 listed in Table I are heterozygous because they were normal in appearance and sired one or more cryptorchid young. All available evidence shows that boar 140.6 was free from the gene. Boar 62.7 was a temporarily fertile bilateral cryptorchid.

In the generation from which the parent stock Nos. 2, 6 and 18.4 were selected there did not occur any cryptorchids. The dam of 18.4 produced also 27 other normal appearing boar pigs.

In the first generation of brother × sister mating a total of 32 boar and 36 sow pigs were produced by sows 2, 4, and 6, all bred to 18.4. Sow 4 is not shown in Figure 4 because she was discarded after one litter had been produced. Sow 2 produced one double cryptorchid boar,

the only one farrowed in the first generation. Obviously boar 18.4 and sow 2 must have been heterozygous although there is a deficiency of cryptorchids on a one factor basis. Since sow 4 farrowed 6 normal boar pigs and sow 6 farrowed 15 normal boars by her full brother and 26 normals by other sires, it must be tentatively assumed that these two sows were free from the defect.

In the second generation of brother × sister mating 97 boars were farrowed by nine sows and 15 of these were cryptorchids. Two of the sows which farrowed only normal appearing boars may be homozygous normals. The other seven sows farrowed a total of 82 boars. If all seven are assumed to be heterozygous then the expected number of cryptorchids would be 20.5 which is not far from the number observed. Of course, the genetic constitution of the sows cannot be established with any great degree of certainty when so few offspring are concerned. Sow 10 farrowed 50 per cent cryptorchids and might, therefore, be considered to be a homozygous defective. In this case one would have to assume that her dam (No. 6) carried the gene and upon this point the evidence is all negative. It seems more likely that the large proportion of affected boars among the offspring of this sow is merely a chance deviation.

In the third generation of brother × sister mating 20 boar pigs were farrowed by five sows and among these were two cryptorchids. One of these was out of sow 53 and the other was out of sow 55. In addition a total of 10 normal boars were farrowed by these two sows. Sows 5, 50 and 52 did not produce any cryptorchids when mated with closely related boars. It is possible that they were homozygous normals although the number of offspring in each case is too small to be considered conclusive on this point.

In the fourth generation of brother × sister mating five cryptorchids occurred out of a total of 27 boars farrowed by two sows, 54 and 3.2. Both carried the gene and it is evident that this may be just another case of heterozygote × heterozygote in which one-fourth of the offspring are affected. One of these boars was the bilateral cryptorchid 62.7 whose fertility will be discussed in a separate section below. Sow 71 shown in Figure 4 was of the same generation of inbreeding as sows 54 and 3.2 but was not used in regular inbred matings. When mated to boar

TABLE I. Comparison of the different matings relative to the production of cryptorchids.

Sow No.	Boar No.	Inbreeding*	Number of Young ♂	♀	Total	No. of Cryptorchids Bilateral	Unilateral
2	18.4	1	11	18	29	1	0
4	18.4	1	6	5	11	0	0
6	18.4	1	15	13	28	0	0
"	48	"	6	11	17	0	0
"	51	"	20	11	31	0	0
7	2.3	2	20	17	37	1	1
8	2.6	2	5	3	8	0	0
9	2.3	2	7	9	16	0	0
"	2.6	2	3	3	6	0	0
10	6.1	2	10	10	20	4	1
11	6.1	2	17	13	30	0	1
12	6.1	2	17	17	34	1	1
13	6.1	2	18	13	31	2	1
5	9.4	3	14	7	21	0	0
51	51.1	2X	2	5	7	0	0
"	140.2	F1X	9	6	15	0	1
"	62.7	4x2	2	3	5	1	0
52	9.3	3	1	0	1	0	0
"	10.3	3	4	3	7	0	0
"	140.2	F1X	3	6	9	0	0
53	9.4	3	7	4	11	0	1
"	3.1	3x2	3	3	6	0	0
"	62.7	4x2	3	8	11	1	0
"	140.2	F1X	9	5	14	0	0
54	3.1	4	3	4	7	0	0
"	5.2	4	4	6	10	0	2
55	11.6	3	5	6	11	0	1
"	140.6	F1X	6	5	11	0	0
60	140.2	2X	10	4	14	0	0
"	51.1	F2X	5	6	11	0	0
"	51.5	F2X	5	5	10	0	0
61	140.2	2X	5	2	7	0	0
"	51.1	F2X	5	7	12	0	0
"	51.5	F2X	4	5	9	0	1
62	3.1	4	3	6	9	1	0
"	3.4	4	7	9	16	1	0
"	5.2	4	10	12	22	0	0
"	140.2	F1X	4	6	10	0	0
63	54.2	3	4	6	10	0	3
65	54.2	3	7	1	8	0	1
"	62.6	3	6	3	9	0	2
66	51.1	F2X	8	8	16	0	0
68	51.1	F2X	6	7	13	0	0
69	54.2	3	14	2	16	4	2
"	62.6	3	7	6	13	0	0
70	54.2	3	5	7	12	0	1
"	54.4	3	2	6	8	0	0
"	62.6	3	2	0	2	0	0
71	54.4	4x3	6	6	12	0	2
74	51.1	F2X	6	5	11	0	0
76	54.2	3	8	0	8	2	2
78	54.4	3	3	4	7	0	0
79	70.6	(2x4)x3	5	2	7	0	1
80	69.1	4	3	2	5	0	0
82	70.6	4	1	4	5	0	0
84	70.6	4	2	2	4	0	0
"	69.6	4	3	4	7	0	2
85	70.6	4	6	4	10	0	2
86	62.6	3	3	1	4	0	2
87	62.6	3	2	3	5	0	1
88	62.6	3	2	1	3	0	0
50	9.4	3	9	4	13	0	0
	10.3	3	2	4	6	0	0

*The numbers indicate the generations of consecutive brother x sister mating. F1X, F2X and 2X refer to Tamworth x Chester White crosses. Certain matings which are not regular brother x sister matings within the same generation are also included. In the data showing number of pigs from each mating the letter C indicates cryptorchids. This symbol is omitted from matings which produced only normal appearing boars.

54.4 a son of sow 54, she farrowed two unilateral cryptorchids in a litter consisting of six boar and six sow pigs. This result shows that boar 54.4 was affected. The importance of this point will be seen below when the progeny of his full brother are discussed.

In the fifth generation of brother × sister mating there were 16 cryptorchid boars among 67 farrowed. It appears that some of the sows which produced this generation may have been homozygous. For instance, sow 69 farrowed six cryptorchids out of 14 boars when bred to boar 54.2. Yet when bred to boar 62.6 she did not produce any in a litter containing seven boars in spite of the fact that boar 62.6 is known to have carried the genes by the fact that he sired cryptorchids when bred to sows 86 and 87. Likewise, sow 76 produced fifty per cent cryptorchids when mated to this same boar.

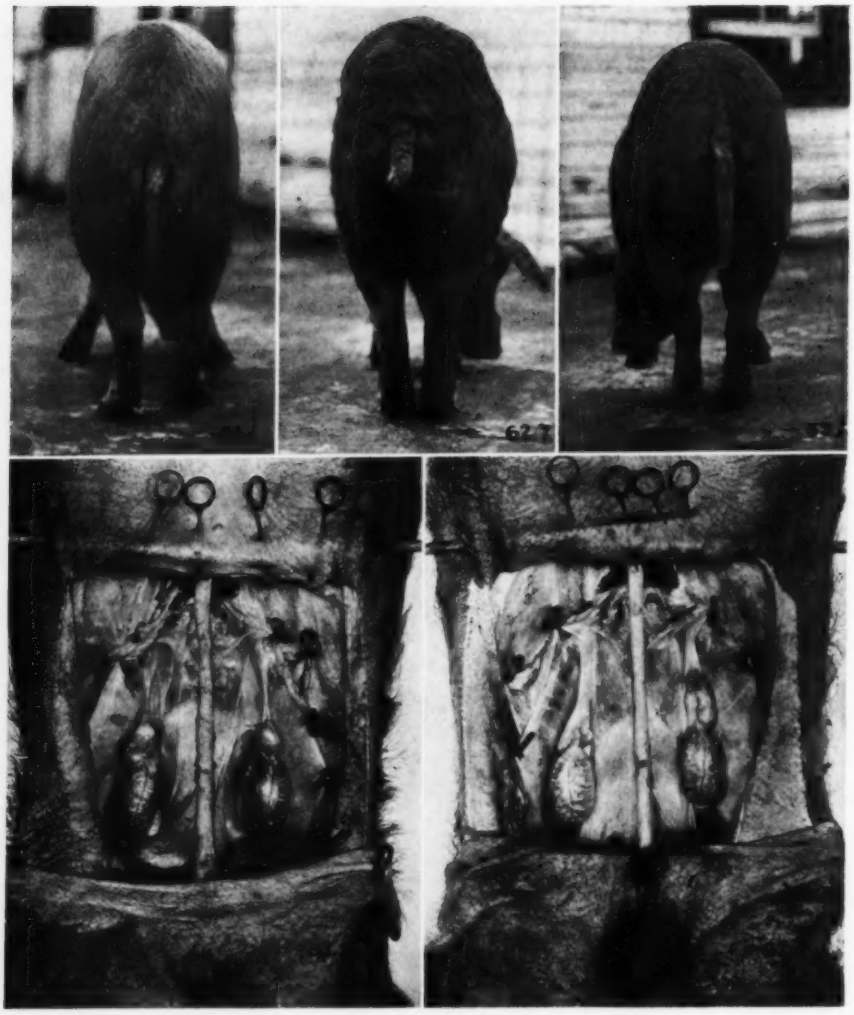
If these sows are homozygous all of their normal appearing sons should be heterozygous. The two sons (69.1 and 69.6) which have been used, however, have not sired a cryptorchid boar thus far. It is interesting to note that they have been mated only to daughters of sow 70, herself a heterozygote, by boar 54.2.

In all of these speculations one must bear in mind that we are dealing not only with the chance segregation of a gene but also with the chance distribution of the sex chromosome whose presence in homozygous condition acts as an effective mask. In the case of sows 69 and 76 the peculiar sex ratio practically eliminates this masking effect and lends further support to the hypothesis that these sows are homozygous for the gene. It is hoped that this idea can be critically tested later by mating these sows to a fertile cryptorchid.

Further evidence of importance is furnished by some crossbreeding studies carried on with this Chester White strain and an inbred Tamworth strain. This experiment was conducted for quite another purpose, however, and the results must, therefore, be considered as supplementary rather than as a critical test. Two Tamworth boars from an inbred strain which in five generations of inbreeding has never produced a cryptorchid were mated to two second and one third generation Chester White sows. One of these (13.9) was out of a full sister of No. 10 which farrowed fifty per cent of affected boars, and by boar 6.1 which was the sire of No. 10's pigs. Another was a daughter of 6.1 and out of his full sister. The third was sow 3.2 which has farrowed three cryptorchids. From these matings, 31 F_1 and 39 F_2 boars were produced. Only one affected male appeared and this one was in the F_1. None appeared among the 17 backcross and F_2 boars. Of course, the F_2 and backcross results can be accounted for on the assumption that the F_1 boars selected were pure normals but the single unilateral cryptorchid in the F_1 is an unexpected result. There are three possible explanations for its occurrence. The Tamworth line may have carried the gene in heterozygous combinations. Second, it may be possible for a homozygous sow to farrow a cryptorchid boar when mated to a male which does not carry any factor for the condition. Third, the single case may have been due to non-genetic causes. The first of these suggestions is practically eliminated by the records on the Tamworth line which are entirely negative for the occurrence of cryptorchidism. Which of the other two suggestions is the correct one is not possible to say. The case does raise the interesting question whether there may not be a genetic difference between unilateral and bilateral cryptorchids. Further data are required to settle this point.

Fertility of Cryptorchids

It is generally considered that bilateral cryptorchid boars are sterile.



A FERTILE CRYPTORCHID AND HIS SONS

Figure 3

In the top row are shown rear views of the bilateral cryptorchid boar 62.7 and his two bilateral cryptorchid sons, 51.1 and 53.6. Below are shown views of the abdominal cavities in boars 62.7 and 51.1, showing the location of the testicles. In boar 53.6 a similar condition was found.

Doubtless there is much foundation in fact for this widespread belief but there is a scarcity of experimental proof of the contention. The writer has been unable to locate a published report dealing with fertility in such individuals and it was not until the occurrence of the temporarily fertile boar No. 62.7 in this investigation that particular attention was given to the matter.

Boar 62.7 was a fourth generation brother × sister inbred son of sow 3.2 and by her brother 3.1. His pedigree is shown in Figure 4, and a rear photograph in Figure 5. Another photograph of this boar taken right after slaughter and showing the presence of both testicles in the abdominal cavity is given in Figure 5.

This boar showed sexual activity at an early age and it was decided to give him a breeding test. Accordingly he was mated with four sows and settled two of them. These sows were second generation inbreds in the same strain as 62.7. One was known to carry cryptorchidism and the other was strongly suspected. One had a litter of two boars and three sows. The other had a litter of three boars and eight sows. A double cryptorchid appeared in each litter. On the assumption that these were backcrosses of the heterozygous to the homozygous recessive it would be expected that half of the boars would be cryptorchids.

Further attempts to settle sows mated to 62.7 were without success although he was a very eager breeder. As an additional test he was mated to 8 sows which were slaughtered at periods ranging from three to fourteen days after breeding. Counts were made of the ruptured follicles and corpora lutea and attempts were made to recover the embryos. Counts showed that a total of 110 eggs had been liberated. Although over 90 per cent recovery was made of eggs liberated up to three and a half days, not a single case of fertilization was found. In cases older than this where unfertilized eggs would be expected to have been resorbed and only embryos remain, nothing was found. It is clear, therefore, that 62.7 was only temporarily fertile.

The two bilateral cryptorchid sons of 62.7 were raised and both developed sexual activity. Boar 51.1 was mated to three sows which were soon to be slaughtered. From one of these which had liberated nine eggs, nine normal embryos were recovered four days later. Another sow which was slaughtered three days after breeding had liberated 11 eggs but only one was recovered. This was in the 4-cell stage and appeared to have ceased development. The third sow liberated 34 egg cells but no traces of embryos could be found 15 days after breeding.

The other bilateral cryptorchid son, 56.6, was also bred to three sows. Two of these were killed three days later and all 15 eggs which had been liberated were recovered from the uterus unfertilized. The third sow was slaughtered 13 days after mating. Ten eggs had been liberated but recovery was negative.

These results prove beyond any doubt that some bilateral cryptorchid boars may produce viable germ cells. This point was followed up by an examination of the testicles when these boars were slaughtered. It will be seen in Figure 5 that in all three the testicles were in the abdominal cavity. They were considerably under normal size. Microscopic examinations showed the absence of spermatozoa in the epididymis and histological study of testicular tissue revealed small seminiferous tubules and generalized atrophy of the reproductive tissues. It was clear that no spermatozoa were being produced in the testicles of any of the three at the time they were slaughtered.

It has been shown experimentally by Moore[3] that the removal of the testicle from its normal scrotal posi-

tion to the abdominal cavity results in a rapid deterioration of the reproductive tissue. It has also been shown that this phenomenon is associated with the higher temperature of the abdominal cavity. In view of these observations some explanation is required to account for the fertility of the two cryptorchids discussed above.

Although there never was any observable descent of the testicles into the scrotum there still remains the possibility that there may have been a partial and temporary descent which escaped observation. The fact that both of the successful matings of 62.7 were made in the latter part of November and his unsuccessful tests the following May indicates a possibility of temperature effects. Further support is given by the fact that the nine normal embryos (100 per cent fertilization) from boar 51.1 were obtained from a mating made in the middle of December whereas the case of one egg fertilized out of 11 was obtained from a mating on May 19. The evidence from these cases of fertile bilateral cryptorchids is therefore not necessarily contradictory to our previous conceptions of the association of sterility with the higher temperature of the abdominal cavity.

Elimination of the Character

Recommendations which have already been made for the elimination of cryptorchidism from the herd are not changed by the information found in this study of the inheritance of the character. For some time the advice given has been to eliminate all boars and sows which have been the parents of cryptorchids and use only normal appearing boars. This advice will stand unchanged, at least until it has been shown that a sow homozygous for the defect can farrow cryptorchids by a cryptorchid free boar.

It is interesting to speculate upon the results of the elimination of a character so widely distributed among breeds of swine if the recommended method were followed. Some of the most noted boars in swine history have carried the defect in their germplasm. There is serious question whether their elimination might not have resulted in greater harm than did the occurrence of a small percentage of cryptorchid offspring. Whether the association of the defect with many other very desirable characters was a matter of mere chance in these cases cannot be answered at the present time. The only light which the present study throws upon this point is that the matings and the sub-strains which persisted under the system of intense inbreeding were the ones which possessed the most desirable characteristics of good hogs. In fact the daughters of the bilateral cryptorchid boar 62.7 had some of the most superior carcass characteristics of any of the slaughtered individuals in this inbred strain. The writer admits that this may have been a mere coincidence.

The producer of market hogs probably should look at the matter in a broad way and make corrections in his breeding stock gradually so that a minimum of financial loss will result. As Nordby pointed out, the economic loss is not great when monorchids from which the descended testicle has been removed by castration are marketed by six months of age.

The breeder of purebred stock, however, should give more serious consideration to the matter because his stock is not going directly into the slaughter house but into widely separated herds where it will have the maximum opportunity of disseminating the defect. The method of elimination is available but its application is up to the breeders themselves.

Summary

1. Cryptorchidism in swine is a sex-limited recessive character. Most if not all of the cases can be accounted for on a one factor basis.

2. There may occur cases which are not of an hereditary nature.

3. Inbreeding results in a fixation of the factor for the condition with the resultant increase in proportion of cryptorchids.

4. Normal appearing boars may transmit the character. The genetic nature of sows relative to the character can be estimated only by a breeding test. Even by this method the separation of those homozygous from those heterozygous for the condition is not accurate.

5. Bilateral cryptorchid boars may in certain rare cases be temporarily fertile. The exhibition of ability to copulate is not necessarily associated with fertility in such individuals. It is suggested that cases of temporary fertility are associated with either a temporary and partial descent of the testes or to the lower temperatures which prevail during certain seasons of the year.

6. Cryptorchids should never be used as sires.

7. The only certain method of elimination of the condition from the herd is to discard all sows and boars which have produced a cryptorchid.

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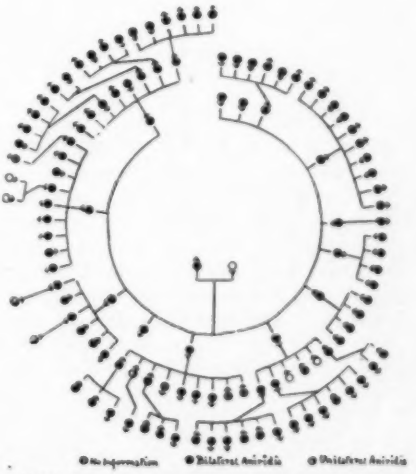
A Spurious Case of Inherited Eye Defect

DR. KEELER mentioned in his discussion of hereditary blindness (see page 289) that individuals suffering from such defects are prone to conceal the fact that they have relatives similarly afflicted. This quite natural tendency must always be guarded against by the investigator who is attempting to obtain accurate information regarding the heredity of human defects and diseases. Curiously enough the student of human genetics must also bear in mind that he will occasionally encounter just the opposite tendency—wherein the victim of a defect, instead of suppressing information regarding relatives who are also afflicted, indulges in a veritable mania of making up imaginary relatives affected by the disease in question.

Dr. Julia Bell of the Galton Laboratory calls attention in *Nature* (London)



WHAT IS WRONG WITH THIS PEDIGREE?

Figure 6

for April 14, 1934, to such a pedigree which has been quite widely circulated in the literature:

A very remarkable pedigree of aniridia was published in 1915 by an American opthalmologist, Samuel Risley. It was undoubtedly issued in good faith by a man, now dead, who accepted, without verification, the statement of a hospital patient who suffered from the defect. This almost blind man, aged 27, described the occurrence of a total absence of iris in 111 of his 119 relations in four generations; he gave moreover, the age, or age at death, and the Christian name of most of these 119 relations; his statement was confirmed, from hospital notes, in the case of one individual only.

Now this pedigree is such as to arouse instant mistrust on the part of a geneticist. A few years ago, I took some considerable pains to get in touch with the family to obtain support for the facts. These efforts met with no success, and I was ultimately advised by the late Dr. Lucien Howe, a former president of the American Opthalmological Society, who had also inquired into the matter, that the history was entirely untrustworthy and should be suppressed.

Risley could never have considered the facts presented to him by his "junior house surgeon," for he even included the statement concerning one case of *bilateral* aniridia, that the woman had one blue eye and one black eye.

Unfortunately, the history has been repeatedly reproduced in America and in Great Britain; recently it has been made use of for propaganda purposes. It was even presented to the Prevention of Blindness Committee by a witness who was called, as an expert, to advise on the prevention of blindness due to hereditary causes. * * * *

It is curious that a pedigree which on the face of it shows a type of inheritance inexplicable on the basis of any known genetic laws, should have been so widely accepted and disseminated. In dominant inheritance with continuing outcrosses to normal individuals we would expect half the offspring of such heterozygous dominants to show the defect. Chance will, of course, alter the ratio of normals to defectives in almost every mating, but such a constant and overwhelming preponderance of affected individuals as is shown in this pedigree would occur by chance only in an almost inconceivably large number of trials. It is to be hoped that a wide publication of the fact that "anecdotal pedigrees" may vary either in the direction of too few or of too many cases may tend to prevent the further dissemination of this spurious pedigree and to put students of human heredity on their guard against other cases of overenthusiasm in hereditary affliction that may be brought to their attention.

Hereditary Absence of Fingernails

TAGE KEMP and P. V. Anderson report (*Ugeskrift for Laeger,* Copenhagen) a family in which absence of the nails (anonychia) or atrophy of the nails is inherited as a dominant character in six generations, 19 out of 33 members showing the defect. In some cases only the nails were defective but there was a tendency for the affected individuals to show bone and joint defects and scanty hair.

AMERICAN WILD COTTONS WITH THIRTEEN CHROMOSOMES

THOMAS H. KEARNEY
U. S. Department of Agriculture

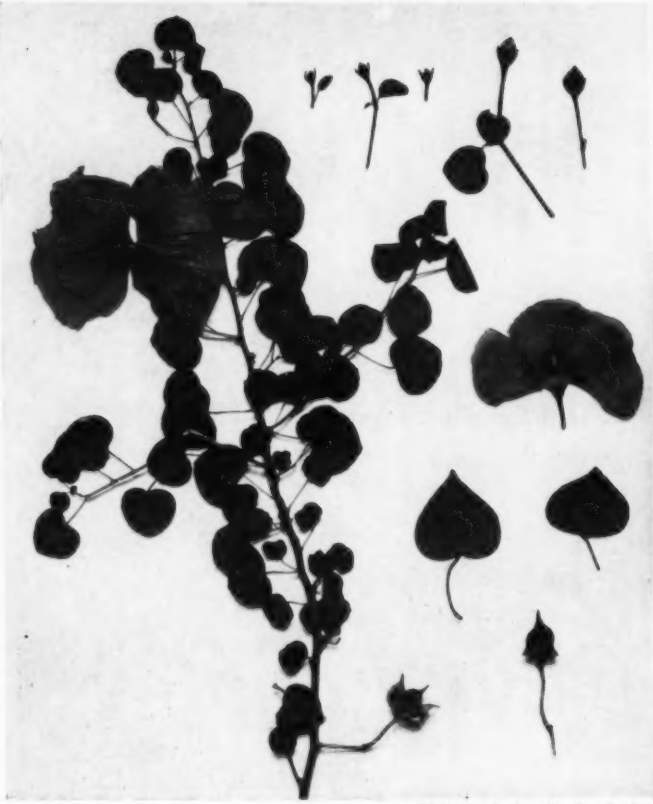
COTTON plants are found growing wild in many tropical and subtropical countries. Most of these resemble, in greater or less degree, forms that are now in cultivation and their seeds bear the long lint hairs that are capable of being spun into yarn. It is always uncertain whether plants of this character are not relics of former cultivation, rather than representatives of truly wild species; although, of course, the forms that were domesticated originally, must have had seed hairs long enough to be utilized by man.

There are, however, several species of Gossypium, growing in remote places, under extreme conditions of environment, and characterized by the absence of lint hairs on the seeds. Unlike the cultivated forms, their characters are sharply defined and they show no evidence of interspecies hybridization. Such are *G. stocksii* Mast. of the shores of the Persian Gulf, *G. sturtii* F.v.M. of western Australia, *G. klotzschianum* Anderss. of the Galápagos Islands and *G. davidsonii* Kellogg, *G. harknessii* Brandeg, and *G. armourianum* Kearney of the shores and islands of the Gulf of California. All of them seem too much like the cultivated cottons in habit and in most of their morphological characters to justify their exclusion from the genus Gossypium, as was proposed by Zaitzev,[16] although one, or perhaps two, of the Lower California species belong technically to Cienfugosia, rather than to Gossypium, as the two genera usually are defined.[7]

The cultivated cottons of the Old World differ from those of the Americas in many of their morphological characters. Domestication of Gossypium undoubtedly took place independently in the two hemispheres.[6] It has long been known that crosses between American and Asiatic cultivated cottons are very difficult to make and that the hybrids are invariably sterile; but within each of these main groups, interspecies fertility is almost unlimited. A cytological basis for this condition has been found in the fact that the haploid number of chromosomes is 13 in the cultivated Asiatic cottons, whereas the number is 26 in the cultivated American cottons, and in wild forms that are obviously related to them, such as *G. tomentosum* Nutt., *G. darwinii* Watt and *G. jamaicense* Macf.

It has been discovered recently, by Youngman and Pande,[15] Longley,[10] Lans,[8] Skovsted[12] and Webber[14*] that all of the lintless wild species mentioned above possess the smaller number of chromosomes ($n = 13$) of the Asiatic cultivated cottons, although none of them, excepting *G. stocksii*, resembles the latter in other morphological characters. It is particularly interesting that the four American lintless species resemble, in their chromosome complement, not the American but the Asiatic cultivated forms. If tetraploids could be obtained by intercrossing these lintless American species,[3] one wonders whether such forms would bear any resemblance to the American cultivated cottons. It would seem, however, that the 13-chromosome spe-

*It should be noted that the determination of n=13 reported for *Gossypium harknessii* Brandeg. by Longley and by Skovsted, was made on material of the recently published *G. armourianum* Kearney. Webber has found the number to be 13, also, in the true *G. harknessii* and has confirmed this number for the other American lintless species, *klotzschianum, davidsonii* and *armourianum*.



Photograph by R. L. Taylor

Photograph by Claude Hope

A THIRTEEN CHROMOSOME AMERICAN COTTON

Figure 7

Plant and herbarium material (the latter 1/3 natural size) of *Gossypium armourianum*. The plant was grown at the U. S. Acclimatization Garden, Bard, California, from seeds obtained on San Marcos Island in the Gulf of California. In comparison with its nearest relative, *G. harknessii*, the branches are much more numerous and spreading and the leaves are much smaller. Note the relatively small, barely cordate, entire leaves. Note the tiny involucel of the young flower buds (upper left) and the dentate calyx of the older flower buds, from which the involucel has already fallen (upper right).

A

B

A

B

Photographs by R. L. Taylor

TWO SPECIES OF THIRTEEN CHROMOSOME COTTON

Figure 8

Gossypium harknessii. Note the relatively large, deeply cordate, distinctly lobed leaves and the involucel on the attached flower, which is large in comparison with that of *G. armourianum* (Figure 7) and persistent until anthesis.

Gossypium davidsonii, a species of lower California and the coast of Sonora. Note the large, lacinate, 3-bracted involucel (upper right-hand corner), which persists until maturity of the fruit, as in the cultivated cottons. (One third natural size.)

Photograph by A. D. Harvey

THE GALAPAGOS ISLAND COTTON

Figure 9

Another of the thirteen chromosome American cottons, *Gossypium klotzschianum,* is limited in its distribution to the Galápagos Islands off the coast of Ecuador. Like the other cottons in this group it has no lint hairs on its seeds but it resembles the cultivated cottons in so many characteristics that its inclusion in the genus *Gossypium* is amply justified. Note the large, persistent, laciniate involucel, the very plicate petals and the relatively small, striate spot near the base of the petal. The plant from which this material was taken was grown at Torrey Pines, California, from seeds procured by Dr. A. K. Fisher in the Galápagos Islands. (Natural size).

cies of the western hemisphere are morphologically too different from the cultivated cottons of American origin to make this at all likely.

The relation between the haploid chromosome number and the presence or absence of lint on the seeds is an interesting one. Of the 13-chromosome species, some have lint and others are lintless whereas no lintless species with 26 chromosomes is known.

The four American lintless species, all of which are shrubs of attractive appearance (Figure 7), fall into two groups. *G. davidsonii* of the shores of the Gulf of California (Figures 8 and 10) and *G. klotzschianum* of the Galapagos Islands (Figures 9 and 10), although specifically very distinct, are similar in the pronounced velvety pubescence of the twigs, leaves and involucel and in having the involucel composed of large, deeply laciniate bractlets, and persistent until maturity of the capsule. On the other hand, in *G. harknessii* (Figures 8 and 10), and *G. armourianum* (Figures 7 and 10), the plant is nearly glabrous or at most puberulent, and the involucel, composed of smaller, entire or shallowly dentate bractlets, is caducous at or before anthesis. Since genetic and cytological investigations of the American 13-chromosome species are in progress at several institutions, it seems worth while to call attention to their salient distinguishing characters. This is done, in the form of a key, at the end of this paper.

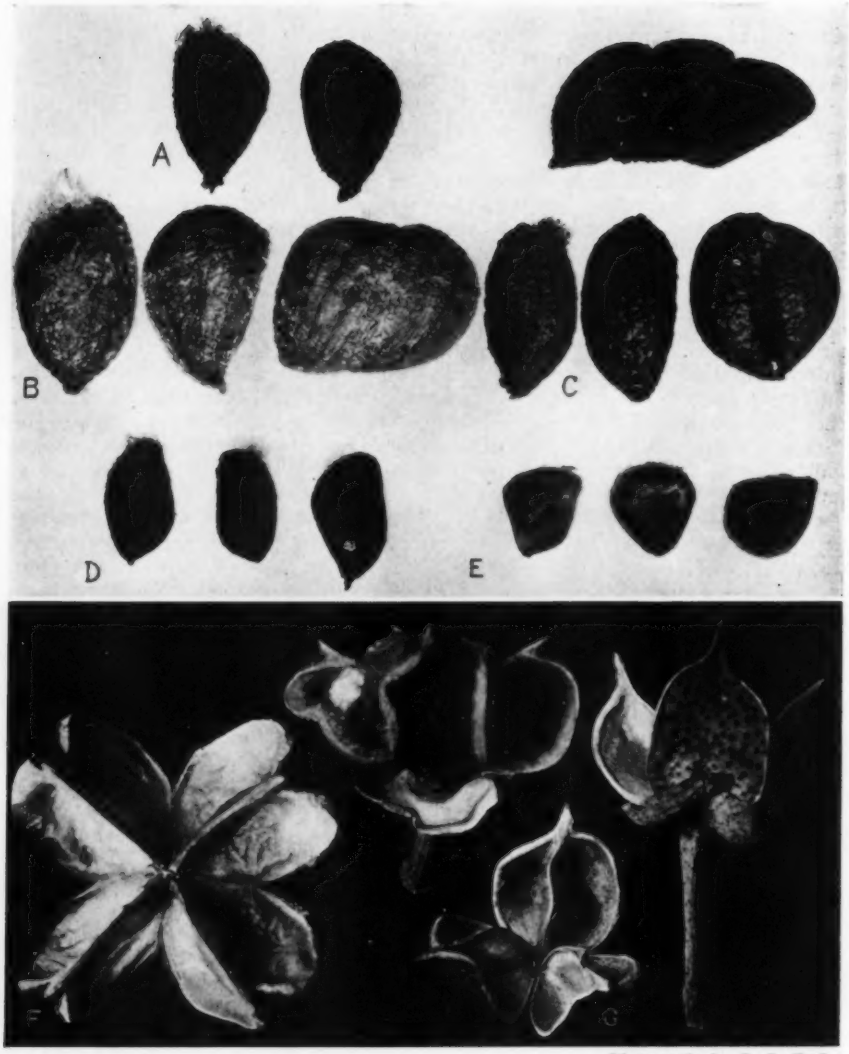
The West Australian *Gossypium sturtii* seems to be distantly related to the American lintless species.* It has a relatively large involucel that persists until maturity of the fruit, as in *G. davidsonii*, *G. klotzschianum* and all cultivated cottons of both hemispheres, but the bractlets are entire. It resembles *G. armourianum* in being glabrous or very nearly so, throughout, and in having entire leaf blades. It differs, however, from all of the American lintless species in its very glaucous twigs and leaves, in the color of the petals, which is mauve-purple rather than yellow, and in having the column staminiferous nearly to the base; also in the seeds, which are slender, pointed at both ends and covered with pale green, instead of fox-colored or yellowish, hairs.

The last of the lintless wild species of Gossypium that were enumerated in a preceding paragraph, *G. stocksii* of the Persian Gulf region, shows little resemblance to the American and Australian species. Its affinity appears to be with the cultivated Asiatic cottons, of which it may be at least a collateral ancestor.

There is a fifth American lintless species of Gossypium if, as Todaro and, later, Harland, concluded, *Thurberia thespesioides* Gray† should be united with Gossypium. Harland reached this conclusion from the facts that Thurberia, also, has 13 chromosomes and that he was able to cross it with *Gossypium stocksii*, with *G. davidsonii* and with a hybrid between two species of American cultivated cottons.[5] The character on which Bentham and Hooker,[1] and most of the later authorities, have maintained Thurberia as a genus, is the 3-celled ovary, that of

*It is reported, however, by A. Skovsted (*Jour. Genetics* 28: 422. 1933) that *G. sturtii* resembles the Asiatic, rather than the lintless, wild American species, in the relatively large size of its chromosomes.

†Thurberia has been referred by some authors to the previously published *Ingenhouzia triloba* DC., which De Candolle based upon a drawing of a Mexican plant made by Moçino and Sessé. Examination of a copy of this drawing, obligingly communicated by Professor Hochreutiner of Geneva, convinces the writer that Thurberia and Ingenhouzia are not identical, a conclusion previously reached by P. C. Standley (*Contr. U. S. Nat. Herb.* 23: 784. 1923).



Photographs by R. L. Taylor

SEEDS AND CAPSULES OF THIRTEEN CHROMOSOME COTTONS

Figure 10

Above are shown seeds (3½ times natural size) of the thirteen chromosome American wild cottons (*A*) *G. davidsonii;* (*B*) *G. harknessii;* (*C*) *G. armourianum;* (*D*) *G. klotzschianum;* (*E*) *Thurberia thespesioides.* Some of the seed hairs have been drawn out on one or more seeds of each species, to show their approximate length. In the first three species the seeds are frequently connate. Below are shown mature capsules of two of these species (*F*) *G. harknessii* and (*G*) *G. armourianum.* The hairs of the inner margins of the valves are numerous in the former, very few in the latter. (Natural size.)

Gossypium being described as 5-celled. But 4-celled ovaries are of frequent occurrence in Thurberia, and the ovaries of many of the cultivated cottons of presumable South American origin, e.g. the Sea Island and Egyptian cottons, are normally 3-celled. Gray,[4] and more recently Watt,[13] laid much stress upon the presence, in Thurberia, of a fringe of long hairs on the inner margins of the valves of the capsule*; but such hairs are occasionally present in some of the cultivated cottons[2, 11] and are remarkably well developed in one of the Lower California wild species, *G. harknessii*.[9] The deeply dissected leaves of Thurberia are closely imitated in the so-called okra-leaf variation of the cultivated Upland cottons (*G. hirsutum*) and in the nearly related *G. schottii* Watt etc., of Mexico.

The small and narrow bractlets of the involucel of Thurberia separate this species from most species of Gossypium; but in *G. armourianum* (Figure 7) the bractlets are even smaller and are deciduous long before anthesis, whereas, in Thurberia, as in most Gossypia, they persist until the capsule matures. The relatively shallow corolla and the differently shaped (turbinate) seeds (Figure 10) seem to be the only characters of Thurberia that distinguish it from Gossypium, although the shape of the seeds is not more peculiar than in the Australian *G. sturtii*. It is, perhaps, significant that Thurberia is the normal host of a beetle that entomologists consider to be only a subspecies of the cotton boll weevil and that will attack cultivated cotton plants when opportunity offers.

It is the writer's opinion that Thurberia is entitled to not more than subgeneric rank. It should be said, however, that in the Hibisceae, the tribe of Malvaceae which includes Gossypium and Thurberia, the genera, as now accepted, are very unsatisfactorily defined. Pending a critical revision of the whole tribe, it would seem unwise to attempt to fix the status of Thurberia.

Key to the 13-Chromosome American Species of Gossypium

1. Twigs, leaves and involucel densely soft-pubescent with short, mostly stellate hairs; leaf blades of soft texture; peduncle not clavate, bearing nectaries at apex; involucel persistent until maturity of the capsule, its bractlets large (2.5 to 5 cm. long), broadly ovate, cordate, deeply laciniate, with numerous long, attenuate-acuminate teeth.

   2. Petals strongly plicate, long-clawed, with an inconspicuous, striate, supra-basal spot; capsule tapering from near the base to the acuminate apex; seeds not connate, nor angulate, nor striate nor very densely pubescent, their hairs loosely-appressed and not crispate . . . . *klotzschianum*.

   2. Petals only slightly plicate, short-clawed, with a conspicuous, usually solid, supra-basal spot; capsule abruptly acuminate; seeds often strongly connate, angulate, striate, densely pubescent, their hairs very closely appressed and crispate . . . . *davidsonii*.

1. Twigs, leaves and involucel puberulent or glabrous; leaf blades of firm texture; peduncle subclavate, without nectaries; involucel caducous at or before anthesis, its bractlets smaller (not more than 2.5 cm. long), subulate or narrowly ovate, not cordate, entire to dentate with very few, short teeth.

   2. Twigs and petioles densely stellate-puberulent; leaf blades not shiny, 3 to 6 cm. long, distinctly 3-lobed, usually 7-veined from the base, deeply cordate with the sinus usually very narrow or closed above; peduncle at anthesis 5 to 12 mm. long; involucel persistent usually until anthesis, its bractlets 10 to 25 mm. long, ovate or oblong-ovate, often denticulate or dentate; calyx sparsely gland-dotted, undulate or denticulate on the margin; capsule copiously ciliate on the inner margins of the valves; seeds broadly obovoid, their pubescence silvery gray . . . *harknessii*.

* See *Journ. Heredity* 20: 341-7, figures 19 and 22. 1929.

2. Twigs and petioles soon glabrous: leaf blades shiny, 2 to 3.5 cm. long, not lobed, 5-veined from the base, subcordate with a broad and open sinus; peduncle at anthesis 20 to 40 mm. long; involucel caducous long before anthesis, its bractlets 2 to 5 mm. long, subulate, entire; calyx copiously gland-dotted, dentate with teeth 1 to 2 mm. long; capsule very sparsely ciliate or glabrous on the inner margins of the valves; seeds narrowly obovoid, their pubescence pale brown . . . . *armourianum.*

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A Congenital Defect in Twins

WRITING in the *Journal of the American Medical Association* for February 3, 1934, Dr. C. C. Mechling of Pittsburgh, Pa., reports the following interesting case of a virtually identical developmental defect in a pair of twins:

The occurrence of identical congenital defects in identical twins is a rarity. An instance of this has been observed in male twins, 23 years of age.

The small skin-lined congenital sinus located under the skin over the lower sacrum is usually not observed until inflammation has occurred, and it is probable that many such sinuses exist without ever being discovered. When inflammation, with pus formation, sets in, it will require incision with drainage, and a later excision of the cutaneous-lined sinus, to effect a complete cure.

A vigorous healthy twin, a man, aged 23, was seen with an abscess apparently located in the subcutaneous tissue over the lower sacrum. It was incised and drained and, six weeks later, the acute cellulitis having subsided, was excised *en bloc.* It was positively identified by the pathologist as being of the congenital type—a pilonidal fistula. One year later the second twin presented himself with a similar abscess. It was treated by the same method.

In a series of 7,500 private proctologic cases seen in a period covering twenty years, I have seen seventy-two patients, 0.96 per cent, with pilonidal disease—either the acute abscess or the chronic fistula. This is my first observation of this condition in twins.

BUSINESS LEADERS, PLANO-OCCIPITALS AND "BETTER FEEBLEMINDED"

Reviews of Six Recent Books on Various Phases of Heredity in Human Affairs

◆

WHENCE BUSINESS LEADERS?

THE title of this book* led me to anticipate that it was a collection of biographies. In fact, however, it is a statistical study, based on questionnaires, seeking:

(1) to ascertain from what social classes American business leaders are recruited;

(2) to determine whether the proportionate contribution of each social class to the supply of business leaders is less than, equal to, or greater than the proportion of that class in the population at large;

(3) to throw light, so far as possible, on the relative influence of hereditary and of environmental factors in causing such disparities as may exist between the representation of the several classes among business leaders and their representation in the population at large.

The authors, one an economist, the other a sociologist, come out with the following results:

I. As to the social classes from which American business leaders are recruited they find that, contrary to the American tradition of long standing, the typical figure among present-day business leaders is neither the son of the farmer nor the son of the wage earner. Not more than 12% of those replying to the questionnaire, whom the authors call respondents, had fathers who were farmers, and only about 10% had fathers who were manual laborers. On the other hand, about 56.7% had fathers who were business men—either owners or executives. The data, the authors say, further plainly indicate that the proportion of farmers' sons among successful business men is tending to decrease, and that of business men's sons, (specifically, the sons of major executives) is tending to increase. The former of these tendencies is associated with the steady decline in the ratio of farmers to the total population, but the slack created by the decreasing proportion of farmers' sons is being taken up, not at all by the sons of manual laborers, but almost entirely by the sons of business men, and, among them, by the sons of major executives in particular. The authors think it entirely possible that by the middle of the century more than two-thirds of the successful business men will be recruited from the sons of business owners (large or small) and business executives (major or minor). They conclude, however, that it is not permissible to speak of the present generation of business leaders as a "caste-like group," but that on the other hand there is clear evidence that the representation of the well-to-do classes among business leaders is increasing at a rapid rate, and is likely to become preponderant if the present rate of increase is maintained during the next few decades.

*TAUSSIG, F. W., and C. S. JOSLYN, *American Business Leaders*, Price $3.75, The Macmillan Company, New York, 1932.

II. In regard to the second question, the contribution of each social class in proportion to the numbers in each class in the population at large, the authors reason that if opportunities to achieve in business, and also the native ability wherewith to achieve, were equally distributed among the several occupational classes, each class ought to be represented among business leaders in about the same proportion as in the population at large, and that any considerable disparities between the two series of proportions would be indicative of corresponding disparities in the fundamental factors, whether of environment or heredity, conditioning business achievement.

The tables, however, disclose that the laborer classes, constituting about 45% of the total gainfully employed population, have a representation among business leaders of only slightly more than 10%; while business and professional classes, on the other hand, constituting only about 10% of the total gainfully employed population, contribute to the supply of business leaders no less than 70%. "Here is the outstanding disparity: 10% of the American population produces 70% of its business leaders."

The authors then go on to say that practically all the studies in this field, whether European or American, agree in finding that the middle and upper social classes—by whatever names they may be called, and whatever may be the basis of differentiation from the remainder of the population—contribute by far the largest share of persons distinguished for their achievement in the arts and sciences, in letters, in the professions, and in other vocations; and that this share has been found to be much greater than the proportion of these classes in the population at large. The lower social classes, on the other hand, composed for the most part of manual laborers (whether in agriculture or in industry), contribute a share rarely exceeding 10%, notwithstanding that they constitute everywhere the most considerable element in the population.

"Such are the results obtained by practically all studies of the social origins of leaders in various fields (citing Sorokin, Social Mobility, pp. 282-292); in this respect they are in complete agreement with the results of the present inquiry."

Privilege or Superiority?

III. Coming to the concluding question, why the business and professional classes, which constitute so small a fraction of the population, contribute so preponderant a share of the business talent, the authors proceed to discuss the two contrasting theories, the "privilege" theory and the "superiority" theory. They say that one contention frequently made by the advocates of the privilege view is that higher education being virtually a prerequisite for a career in the professions, in the arts, or in letters, sons of laborers are debarred from entering these callings, not to speak of succeeding in them, but that whatever weight may be given to this contention, it is surely of less account when taken with reference to business leaders because it has never been of cardinal importance for entering business that a man should have a college education or even training in commercial subjects. Yet the proportion of laborers' sons among business leaders (10.8%) is not markedly larger than their proportion among the professional and literary leaders represented in "Who's Who" (6.7%) as ascertained by a different study.

"The small amount of the difference clearly suggests that it is not the inability of wage-earners sons to enter a calling that is primarily responsible for their inability to achieve success, but rather some other unfavorable condition by which they are handicapped."

The authors' questionnaire covered three environmental factors: financial aid, influential connections, and for-

mal education. About 12% of respondents stated that they had received financial aid, substantial in amount, during the early stages of their business careers. From this, the authors conclude that help of this kind is not common enough to make it characteristic of the present generation of business leaders. Their conclusion is the same, though less positively so, as to influential connections. About 36% of the respondents stated that they had relatives or friends interested, as owners or executives, in their first or present business. The 36% should not be added to the 12% because 8.4% had the benefit of both financial aid and influential connections. This leaves about 40% of the sample who received help of some kind from relatives or friends—either influence or financial aid, or both.

As to schooling, about 25% of the respondents had no more than a grammar school education; 28% had high school training or its equivalent; 13% had some amount of college training, but did not graduate; and 32% were college graduates. The authors conclude that none of these proportions is large enough to make it characteristic of the entire sample. Their general conclusion as to the three environmental factors is: "Success achieved without help from relatives or friends appears to be more typical than success achieved with such help. If any presumption can be said to have been established by the findings, therefore, it is that ability (whether innate or acquired) rather than environmental factors independent of ability, has been prepotent in determining the success of the business leaders in our sample. The data on the extent of schooling entail no modification of this conclusion—indeed would not, even if the proportion of college graduates were much larger—since, so far as we can judge, the degree of schooling completed by an individual is fully as much an index of his ability as it is a determinant."

They further conclude that there is no considerable suppression of business talent in the less favored economic classes.

As to the relative influence of heredity and environment, the authors correctly say that a final answer could be given only by work of far wider scope, and different character, and with the use of evidence from many sources.

By combining the figures in one of the tables in the book, I find that the following appears (Table I*).

American Business Leaders is a book for the investigator rather than for the general reader who, although the subject matter is presented as well and lucidly as its statistical nature permits of, would find it rather hard going. The sections dealing with the first two questions which the authors set themselves are convincing and valuable. The third section, the one dealing with the relative effect of heredity and environment, is not so persuasive. Only the three

***TABLE I**

Distribution by Size of Business Grades of 3,864 Respondents (Chief Executives Only) Classified According to Occupation of Father.

	Occupation of Respondent's Father				
Size of Business	Laborer (all grades of skill) (377)	Farmer (491)	Clerical and small business (1195)	Big business (1286)	Professional (515)
Grades A & B (biggest and next biggest)	29.2	35.5	36.9	41.9	45.3
Grades C, D & E (smaller)	70.8	64.5	63.1	58.1	54.7
All Grades	100.0	100.0	100.0	100.0	100.0

environmental factors mentioned are considered, but of course there are in life a host of others. As for the three studied, although the authors' interpretations may be quite correct, I have the feeling that if one confines himself to the tables, and excludes everything else that he knows, one may perhaps find it a little difficult or unwelcome to draw too convincing conclusions from the figures representing the compiled results of answers of business leaders to brief questionnaires. The mind desires something more,—a different or supplemental method of approach. And some of the reasoning of the authors, though very likely right, makes one want to take up the cudgels for the under dog.

Haud facile emergunt, quorum virtutibus obstat
Res angusta domi.

Reflections of a general nature suggest themselves. Does every society after it passes out of the agricultural and enters into the financial-economic phase tend to generate a cast-like group at the top and a proletariat and peasantry at the bottom?* If so, is it a biological or an economic phenomenon? Or both? Are the lower classes drained of their ability, and if so how long does it take? Is the authors' conclusion in section I that the representation of the well-to-do classes is increasing at a rapid rate and is likely to become preponderant if the present rate of increase is maintained during the next few decades entirely consistent with their "superiority" conclusion in section III?

We are told on high authority that some 200 corporations with slightly more than 2,000 directors control the conditions under which most American industry must operate. What effect does this have?

A variety of "remarks" made by the respondents is quoted in an Appendix. They are full of human interest. A few of them are, in part, as follows:

"Had good fortune of getting sensible wife at 23."

"I was brought up in a small town where I learned that work was the normal lot of man, not a misfortune, as is taught now."

"Close observation for many years leads me to believe that social and economic origins have very little to do in the making of our American business leaders. The controlling force is an inward urge for attainment given to a few."

The "remarks" also stress the value of friendship, luck, personality, influence of mother, initiative, accounting, college, schools of business science, working way through college, and extracurricular college activities. One man reports his relatives a detriment, and one thinks that in these prosperous times keeping a boy in school until he is 24 tends to make him a dependent, or defer the time when he can go on his own with confidence.

The subject has many angles.

A regular progression is here obvious, which may be compared with intelligence tests in schools, the following being one by Miss A. H. Arlitt of Bryn Mawr College:

		I. Q.
1.	Children of professional men	125
2.	Children of semi-professional men and higher business	118
3.	Children of skilled labor	107
4.	Children of semi-skilled labor and unskilled labor	92

Weld A. Rollins

Boston, Mass.

*Adams, Brooks, *Civilization and Decay*, Pp. 14, 44, 87.

FAMILY BACKGROUNDS OF MORONS AND IDIOTS

ATTENTION to different degrees and types in studying the distribution and the causes of mental deficiency has been emphasized in various studies including the report of the Mental Deficiency Committee in England, 1929, and by Holmes in "The Eugenic Predicament." Recent studies* at the Keller Institution for Mental Defectives in Denmark bring out this distinction with great force. The Institution has two branches, a "school" for high grade "oligophrenics" with intelligence quotients between 75 and 90 (classed as "dullards" and "simple-minded") and an "asylum" for low grade oligophrenics (classed as "idiots" and "imbeciles"). Selecting cases at random from these two groups, Dr. Wildenskov, the director of the Institution, has made a comparative study of family backgrounds and other conditions affecting their development. This investigator wisely, we believe, prefers intensive study of small samples to the use of a large body of data carelessly collected. Accordingly, he has investigated only 50 families in each series, but he has carried out all the investigations personally, visiting homes, collecting school records and hospital records, and sifting hearsay evidence on medical history and mental development. In some cases mental tests were used, but this procedure was usually impossible in studying family histories, so that the ratings are for the most part merely the subjective judgments of a competent physician.

Perhaps the most serious limitation in this work is that the author is concerned entirely with the physical basis of mental deficiency. He deals with two main sets of factors, "endogenous" hereditary factors, and such "exogenous" factors as birth trauma, infectious diseases, and poisoning. He does not take into account the possible effect of poor cultural melieu in retarding intellectual development, either through lack of stimulus or through inducing complexes and inhibitions. He does not, therefore, provide a complete analysis of the influence of heredity and environment in causing mental deficiency that would satisfy the criteria advanced by Schwesinger in "Heredity and Environment" or by Hogben in "Nature and Nurture." Therefore, when Wildenskov's results show the strong tendency of certain types of mental deficiency to "run in families," we must reserve judgment on the extent to which such familial association may be influenced by cultural factors. This limitation in interpretation, however, does not in any sense detract from the validity or importance of the results established. It should also be noted that the investigator eliminates at the start certain special types of mental defect (mongolism, tuberous sclerosis, and myxoedema), in order to concentrate attention on the far more frequent cases which do not fall into these limited categories.

Distinct Social Backgrounds

The social backgrounds of the two groups are strikingly different, the cases of severe mental defect (the "asylum" material) being distributed more or less at random in the general population, whereas the mildly defective children were drawn in large part from families of unskilled laborers. In this case this resuit might be attributed in part to selective factors, but it is confirmed by other studies, including the extensive Mental Deficiency Survey in England. The difference in the frequency of mental defect in the living sibs and parents of the children studied in these two groups is even more marked, extreme mental defect being far more sporadic in its appearance than moderate deficiency. For ex-

*WILDENSKOV, H. C., and EJNAR MUNKSGAARD. *Investigations into the Causes of Mental Deficiency.* (Translated from the Danish by Hans Anderson). Oxford University Press, London, 1934.

ample, among 207 living brothers and sisters over five years of age in the families of the "school" group, 22 per cent were classed as having marked mental defect and another 29 per cent as intellectually retarded ("dullards" and "simple-minded"), but among 196 living sibs of similar age in the families of the "asylum" group only 18 per cent were classed as "dullards" or "simple-minded." Furthermore, the cases of mental deficiency recorded among the relatives of the "asylum" children were more scattered as regards degree of kinship, and the mentally defective relatives of the "school" children were concentrated to a greater extent in the immediate families of the propositi. Finally, Wildenskov found evidence which he regarded as establishing exogenous causation in 8 cases (16 per cent) of the "asylum" material, but in only 2 cases (4 per cent) of the "school" material. Although, mental deficiency was attributed to birth injuries in 4 cases, to other injuries of the head in 2 cases, and to infections attacking the central nervous system in 4 cases. The investigator records pathological physical conditions in many other cases, but regards these conditions either as insignificant or merely contributory factors or else as symptoms of hereditary defects. The author attaches a complete brief summary of all the case records.

The research described here is well oriented with reference to the work of other investigators. In fact, the excellent rapid review of various studies in this field, with bibliography, adds greatly to the value of the report, especially for American readers who may not be familiar with the recent German and Scandinavian literature on mental deficiency. At some points the investigator reports careful objective tests of hypotheses advanced by other writers. His results seem to demolish theories advanced by Szondi (Budapest). Theoretical discussion gives support to the position advanced by Penrose that developmental disturbances are often complementary to hereditary factors in causing mental deficiency. The author heartily endorses the attempt to free the study of mental deficiency from the "dogma of a monocausal pathogenic defect."

Wildenskov's results, supported by the findings of Brugger, Lokay, the English Mental Deficiency Committee, may now be accepted as establishing the principle that *mild mental deficiency tends to be strongly associated with retarded intellectual development among near-relatives, but idiocy is more sporadic in its appearance.* There would seem to be three possible interpretations of this finding. Idiocy may be due to several rare recessive gene phases, whereas the genetic factors tending to cause mild deficiency may have higher frequency and a larger proportion of these factors may be dominant in their expression. Or, idiocy may be due more frequently to specific, exogenous factors. Or, cultural influences may be important in producing mild intellectual retardation, but incapable of causing idiocy. There may be some truth in all three of these explanations, or in any two of them.

Incidentally, there is evidence that morons and imbeciles tend to come from families characterized by high fertility, whereas the parents of idiots usually do not have larger families than are found in the general population (*see,* for example, Thurstone and Jenkins, Order of Birth, Parent-Age and Intelligence, p. 28). Also, idiots as a class are themselves infertile, but the high-grade feebleminded are not. It seems then that we may look forward to accumulating gradually a "bigger and better" class of mental defectives. However this may be, Wildenskov's study is symptomatic of the development of an increasingly objective, controlled and significant literature on the subject of mental defectives.

FRANK LORIMER.*

*Dr. Frank Lorimer and Mr. Frederick Osborn are preparing a report on qualitative population trends: *Dynamics of Population: The Social and Biological Significance of Changing Birth Rates in the United States,* to be published by The Macmillan Company late in 1934.

ORIGIN OF THE SOCIALLY INADEQUATE

THIS book* should be of great interest to the social worker, for its scope lies more in the field of sociology than in that of genetics, since it is composed almost entirely of pedigrees of socially inadequate families in the east end of London. The author was peculiarly fitted for his task of collecting this information, having been connected for 32 years with the administration of poor law relief in London. He has not attempted in this volume to discuss any theories or to prove any points. He has merely set down the facts about these families which have come under his observation. Yet much can be gained from the pedigrees by the reader who studies them carefully.

One of the interesting facts which I gleaned from the first pedigree was this. There are here recorded 75 matings in which some statement is made as to the social adequacy of both partners. In one-third of the cases, normal married with normal and in another third, inadequates and defectives mated *inter se*. The records of their inadequacy run all the way from being a chronic recipient of poor law relief in some form to insanity. In one-fifth of the cases, the socially inadequate found as a partner a person stated to be normal. In twelve per cent they mated with some one whose record was not known, hence who may or may not have been normal. These percentages are of interest. One sees repeatedly the statement that elimination of this class of socially inadequate and mentally defective cannot be accomplished through sterilization because the process of elimination would be too slow to amount to any noticeable lessening of this group. When one examines the foundation for this statement, one sees that it is based upon a non-selective mating of mankind with respect to intelligence and social adequacy. They assume that persons mate as freely with anyone they encounter as pollens of red and white flowers fertilize each other. Were this assumption true, then we should expect to find 50 per cent of matings in a group like this to be between the normal and the defective, 25 per cent between normals, and 25 per cent between defectives. But we find only two-fifths as many matings as expected between the normal and the defective classes. This is the type of mating which keeps up the supply of normals from whom the defectives are supposed to come in largest quantity, and we see that it does not occur with the frequency which the objectors to sterilization have to presuppose to bolster up their argument. There is, as we know from common observation, a great deal of selectivity in mating.

A second point of interest centering around this selective mating is as follows. Like tends to mate with like, and the socially inadequate mate with those of their own level. Their inadequacies may express themselves differently, however. That means that after several generations of matings among members of this class, there is accumulated in the stock a large number of genes for defective characters of varying types. Some of these crop out in one person, others in another. Thus when one investigates a family tree for epilepsy,

*LIDBETTER, E. J., *Heredity and the Social Problem Group*. Price 21s. Edward Arnold & Co., London, 1933.

one finds a history of drunkenness, neuroses, insanity, etc. Some have thought these were all expressions of a neuropathic tendency which might exemplify itself in protean forms. Lidbetter suggests that what we are finding is merely the segregation of many defective genes carried in the same stock.

He concludes that "The trend of modern movements in all that relates to the socially inadequate is in the direction of their endowment as a class at the expense of the self supporting community. Social organization has proceeded upon the assumption that it can make anything of any man."

Much enlightening information might be gleaned from similar studies on the socially inadequate population of other communities. Only by repetition of these startling facts *ad infinitum* does it seem possible to arouse a lethargic public opinion to the gravity of the situation.

MADGE THURLOW MACKLIN
University of Western Ontario

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THE ALSO-BLESSED PLANO-OCCIPITALS

DR. Otto Aichel is professor of Anthropology and director of the Anthropological Institute of the University of Kiel. In this volume* he essays an anthropological interpretation of the German people with the help of twelve prehistoric crania from Schleswig-Holstein, twenty-three crania from Bolivia and points in South America, a thorough familiarity with contemporary writings on European racial history, and the usual lip service to the racial tenets of Hitlerism.

The following is a summary of Professor Aichel's views. The Neanderthal race is the oldest race in Europe. All of the so-called late Palaeolithic races are the result of crosses between the Brünn long-headed race and the earlier race of Neanderthal. Similar crosses between Neanderthaloids and the Brünn race took place in the New World. Plano-occipital short heads (brachycephals with flat occiputs) came into North Europe at latest in the Early Ancylus time. These plano-occipitals are to be identified with the "Dinaric" race. The fourth fundamental race consists of the curvo-occipital short heads. All of these races originated in Asia. The last named or some part of it took on Mongoloid characteristics during its period of isolation in Central Asia. Differences in skin color, hair color, and hair form do not constitute original racial characteristics, but are in general to be considered late by-products of miscegenation.

The plano-occipitals must be reckoned in the "Nordic" complex which gave rise to Indo-Germanic languages and all else that is good and beautiful, since they arrived so early. Conventional descriptions of the Nordic race are merely recitals of racial ideals which exist as individual combinations and not in an unified racial group. The Nordic race is in itself a product of mixture. Because physical and mental traits have been swapped about indiscriminately in race mixture, one cannot decide that a man has a Nordic soul because he is a dolichocephalic blond. He may be an Alpine sheep in a Nordic wolf's clothing. Racial appearances are deceitful.

The author makes a plea for the reconciliation of political propaganda and scientific research in Germany, which is strongly reminiscent of the writings of the peace makers be-

*AICHEL, OTTO, *Der Deutche Mensch.* Price 23 marks. Gustav Fischer, Jena, 1933.

tween religion and science. He mildly deprecates the use of the terms "Nordic" and "Aryan" in anti-Jewish propaganda, and very sensibly suggests it would be more accurate to stick to "German."

Nearly everything in this book is interesting to the anthropologist and a great many of the author's ideas are essentially sound. Of course, few will agree with his proposals as respects racial classification. Some American anthropologists will view with alarm his suggestion that Neanderthaloids and Brünn people have made unholy alliance in Bolivia, as well as in Europe. I doubt if any will point with pride. One wonders whether Professor Aichel has sufficiently considered artificial deformation of the occiput in his American plano-occipitals.

The reviewer finds *Das Deutsche Mensch* an extremely stimulating work from which he has derived considerable profit and no little amusement. The German professor lacks neither erudition nor imagination, nor yet courage. I am glad that within the official wilderness there is one voice crying aloud to prepare the way for the plano-occipitals. Every physical anthropologist should read this book, but let the amateur beware! Some of the theories require further testing.

E. A. Hooton

Harvard University

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THE HUMAN ENGINEER

THIS volume* is the seventh in a series of books on human relations, dealing particularly with problems of personnel in industry, commerce and education. The author discusses the results of his experimental work with selective tests as applied to those seeking various types of jobs. The tests include pin assembly, block construction, number checking and word reaction types among many others, and the work samples, although not "infallible in their present state of development, predict with mathematical certainty the probability of success or failure." Laboratory work has shown that by and large rapid workers in the checking experiments make fewer mistakes than the slower workers, thus placing the popular expression "slow but sure" in the category of myths; and moreover, the accuracy of the fast worker is likely to extend to other fields.

The comparison of many individuals in controlled laboratory situations has convinced the author that there are fundamental dissimilarities in the rapidity of solving problems which are born in them (i.e. of chromosomal significance) as integral parts and are not the result of home environment, early training or formal education although repetition, training and education may help to overcome some basic inferiorities to a considerable degree. Training may give the "mechanically dull as brilliant a surface as the genius," and "Research discloses many reflexes where environment, in the form of experience, far overshadows initial capacity." Experiments have shown that many individuals ill-adapted to their tasks could have been detected as unfit by appropriate tests and placed in positions for which they were better fitted, within the same industry. This procedure would eliminate failures either in the form of giving up the job or of developing physical or mental illnesses as a result of the over fatigue engendered in the energy output.

In applying the various tests the

*O'Connor, Johnson, *Born That Way*. The Williams and Wilkins Company, 1933.

laboratory situation as such must be taken into consideration and a special technique has been developed to lessen the innate nervousness and timidity which is present in some degree in all subjects, and to make the attitude of the examiner appear neutral. But, under the best of conditions at present only combinations of activities are measured, and no test, as yet, has demonstrated its ability to measure an isolated characteristic. The accuracy of the tests, however, in evaluating an individual for a certain job, as compared with the personal interview method even when the interviewer has been unusually keen, has been outstanding and absolutely conclusive.

The author believes that certain dangers may arise along with the advance in the methods of human engineering:

> Obliterating the hopeless strivings to succeed at unsuitable work may conceivably weaken mankind by rendering accomplishment too simple . . . . success must not be earned too easily, ****
>
> Assigning generation after generation of a family to the same vocation, because the members inherit similar aptitudes, may induce warped freaks; and although man's future progress depends upon specialization any such stifling restriction of one family, whether brought about through biology or through mental tests, would jeopardize individuality.

The risk seems slight, but the human engineer knowing these dangers, and with an increasing refinement of his technique should be able to avoid difficulties by the correct appraisal of both the special task and the individual man and strike a balance in favor of creative trends in progress.

There are chapters devoted to human engineering, personality, limitations in adult education, early training, the future of man, genius, formulation of knowledge, opinion and prejudice, and to the dangers of human engineering. Three extensive appendices comprising half of the volume are utilized in the description, interpretation and reactions to tests. The material is interestingly presented and should prove valuable to both scientists and administrators.

N. D. C. Lewis.
St. Elizabeth's Hospital

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GERMAN VIEWS ON STERILIZATION

THOUGH an appendix gives the text of the German sterilization law, these five lectures* were prepared before the law itself was issued. They are all the more interesting, from one point of view, in demonstrating that the statute is no hasty improvisation of the Hitler regime, but that it had been preceded by years of discussion and study on the part of the best qualified specialists in Germany. In this book E. Baur discusses natural selection, W. E. Muhlmann discusses social selection, Dr. Walter answers the question, "What is unfitness, from the eugenic point of view?" Dr. Althaus writes of the religious aspects of the subject, while Dr. Rosenfeld takes up the legal aspects. It is a useful and interesting contribution to a most timely topic.

Paul Popenoe

**Von der "Verhutung Unwerten Lebens."* A cycle of five addresses. Issued by the Naturwissenschaftlicher Verein, Bremen; published by the G. A. V. Halem Exportund Verlagsbuchhandlung, Bremen, 1933.

THE BOX TYPE FOUR O'CLOCK

A Mutation of Stalk Character in *Mirabilis jalapa*

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AT the Blandy Experimental Farm more than five thousand plants of *Mirabilis jalapa* have been grown and observed since 1929. Among these one case of mutation in stalk character has been found, which because of its leafy compactness has been designated "Box." This mutant differs markedly from the types commonly grown in gardens, and appears to be a more desirable four o'clock for horticultural purposes.

Box arose in the summer of 1931 in connection with a study of flower color inheritance. From a total of 99 F_2 individuals in a cross, Dominant White × Rose Pink, five mutant plants were obtained. Their striking dissimilarity to normal plants was noted only after the flowering season began. This dissimilarity was caused chiefly by the presence of unusually short, or completely reduced internodes at the ends of the branches, and by the presence of leaves which were darker green and crinkly. Subsequent development consisted principally in the proliferation of leaf and flower buds. (Figure 11.) Seeds gathered from this mutant type gave seedlings which in growth habit and appearance were indistinguishable from those of normal plants, except for crinkly leaves, present even at this early stage. To all indications the mutant plants are as vigorous or probably more vigorous, than normal plants, though due to their smaller size, they may suffer from shading when grown too closely alongside normal plants.

Inheritance

Field plantings of selfed seed from the original five mutant plants have yielded only Box plants in the first and second generations. Appropriate crosses have been made in an attempt to detect its breeding behavior with normal plants, and to date two crosses have yielded an F_2.

Reciprocal crosses between Box and normal strains were made during September, 1931. Sets were obtained with some difficulty due to much shriveled pollen, present in the material at the late season during which crossing experiments were made. From 13 crossed seed, 10 F_1 plants were grown. These F_1 plants were all normal, having a growth habit indistinguishable from the stock of the normal parental line. In the summer of 1933, 60 seed were planted in anticipation of an F_2, representing selfed seed gathered from two F_1 plants. A total of 48 F_2 plants came to maturity from this planting, 23 from Cross I, and 25 from Cross II. Of the total 48 F_2 plants 39 were normal and 9 were Box; the expectation on a one factor difference being 36:12.

Discussion

It is probable that Box arose as a single gene mutation in one of the ancestors of the original five mutant plants, namely; in the F_1 or P_1 of the cross, Dominant White × Rose Pink. Due to the dominance of normal it did not become apparent immediately; not until it segregated in the homozygous condition. The mutation could have been either somatic or gametic, but more probably it was somatic. If it had been gametic, taking place in a gamete of the P_1 of the above cross, the F_1 would have been heterozygous for the new character, and in the F_2, segregation

A DWARF FOUR O'CLOCK

Figure 11

The box type of Four O'Clock (left) is conditioned by a recessive gene which differentiates it from a normal. The normal form has the property of growing almost indefinitely while the box form definitely ceases to grow when flowering begins. In this it differs from other dwarf forms of Four O'Clock, which simply grow more slowly than the normal.

would have taken place giving Box as a simple Mendelian recessive. The actual result obtained showing 94 normal to 5 Box plants in a total of 99 F_2 individuals, does not indicate that segregation took place in all the progeny. The evidence can be interpreted more logically by assuming that somatic mutation took place. It probably involved a branch of the F_1 plant in its early development, rendering it heterozygous for Box, and therefore genotypically different from the remaining homozygous normal branches. From selfed seed of the mutant branch normal and Box plants would be expected in an approximate 3:1 ratio; while from seed of normal branches, only normal plants would be expected. However, since the seed were gathered from this plant as a whole, the normal and Box plants coming from them would obviously not be expected to appear in a ratio which would be significant.

The distinction between normal and Box forms of *Mirabilis jalapa* was found to be clear cut, even at a very early age. In normal plants there is a gradation in internode length, growing progressively shorter toward the extremities of the branches. The maximum growth is not attained until some time following the onset of flowering. In contrast with this condition, Box forms characteristically bear terminal internodes which are abruptly shorter than those preceding; so that by the time flowering begins, these plants have attained approximately their maximum proportions.

These observations give grounds for speculation as to the length of time during which the genes for normal and Box exert influence on growth, as well as to the effect they produce. Both are active in determining internode length, beginning probably in the seedling stage. The influence of the gene for normal is exerted over a longer period of time than that for Box. Normal plants have the potentialities for stalk growth until some weeks after the flowering season has begun, depend-

ing upon the number of seed which the plant has set and is maturing. Even the slow growing dwarf types of normal can be induced to grow to a comparatively large size when grown in proper soil, and when not too many seed are being set (this condition can be brought about by clipping the flower buds as they come into blossom). The growth habit of normal is therefore, of a more or less indeterminate nature.

With Box forms the situation seems to be different. At a relatively early period in the life of the plant, that is by the time flowering begins, growth (meaning elongation of internodes) is culminated, irrespective of environmental conditions. Seemingly therefore, the influence for growth is exerted over a much shorter span in the life of the plant, than is the case of the gene for normal; and the result is a more or less determinate growth habit.

Summary

A mutation involving growth habit in *Mirabilis jalapa* is described as Box. In comparison with normal, these plants are more compact and leafy, and have a somewhat determinate growth habit.

Data are presented from appropriate crosses indicating that the mutant type is recessive to, and differs in one factor from the normal type.

Box probably arose as a somatic mutation from a normal plant.

Prizes for Studies in Mental Disease

THE Eugenics Research Association, Cold Spring Harbor, Long Island, N. Y., offers a first prize of $3,000 and a second prize of $1,000 for original researches on the "probability of commitment for a mental disorder of any kind, based on the individual's family history." Contestants are at liberty to pursue their own technique in making their investigations, but the association offers to supply a plan which it believes best adapted for the purpose of the contest, which is "to clarify and render more precise the prognostic value of the hereditary factor in the occurrence of mental disorders." The association prefers to be notified by those intending to enter the contest, although this is not obligatory.

Adequate typewritten reports must be presented under a *nom de plume* to the Eugenics Research Association on or before July 1, 1935, accompanied by a sealed envelope containing the name and address of the contestant. The awards will then be made by three judges appointed by the association, whose decision will be final. The text of the prize-winning researches will be published in book form by the association.

"It is to be clearly understood," the announcement states, "that the probability of commitment to an institution is the criterion upon which the research must hinge," and "the criterion for 'mental disorder' shall be as objective as possible.

"The best criterion is 'commitment to an institution, public or private, of any sort for mental disorder of any sort.' This includes, particularly in the old days, poor houses and other 'quest-institutions' for custodial care. Evidence of disordered behavior for a member of a subject family, even if there has been no actual commitment, may be accepted for a period or location which is without institutional facilities.

"The conditions require that evidence of mental disorder shall be based only on the most objective facts, that is, commitment to an institution of some sort or its equivalent in legal restraint or guardianship. This condition protects the research essayist against arbitrarily diagnosing passing stories of strange or disorderly conduct as evidence of mental disorder. The criterion is, therefore, placed at actual custody or guardianship of some sort. . . .

"The criterion of mental disorder is not merely biological; it is social and economic as well, and it depends upon (a) the incidence and degree of disorder, (b) the policy, past and present, and facilities of the community and state, past and present, for institutional commitment of the mentally disordered, and (c) the economic status and social contacts of the family."

WOOLLY HAIRED CACTI

Figure 12

Ordinarily this species of cactus (*Echinocereus chloranthus*) is equipped with a complete armament of robust spines, but some plants have fine white hairs instead of spines in the juvenile stage. These hairs are replaced with spines as the plants grow older, as is shown at *B*, where the plant has a hairy base and spines above. The plant in the center at the left has a band of spines and later has produced hairs again to be followed by spines at the tip. (One other plant showing a similar "pattern" was also found.) The plant above this at the right is beginning to produce spines at the tip. While spines are an extremely variable character in cactus, the fact that this hairy type was restricted to a definite region suggests that it probably has a hereditary basis.

A NEW SPINE CHARACTER IN CACTUS

Echinocereus from Texas Shows "Woolly" Character in Juvenile Stage

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Bureau of Plant Industry, U. S. Department of Agriculture

THERE is frequently a great deal of variation in plant characters among cacti. Some species have a wide geographic range and grow under very different conditions of climate and environment. Plants growing on a barren desert hillside where the only supply of moisture is an occasional shower will naturally differ in appearance from some of the same species whose home may be in the mountains in the shade of trees, where the soil is more fertile, the moisture more plentiful, and the temperature more moderate, but minor variations are also often found among individuals of the same species even when they are growing in the same locality.

Probably the least stable characters of the cactus family are those of the spines. It is often difficult, if not impossible, to identify species by their spines; the sometimes vague differences appearing to be bridged over by variations within each species. Under abnormal conditions of growth, changes in the characters of the spines and other parts are the rule rather than the exception. Joints of some of the Platyopuntias, when grown indoors, make a slender, cylindrical growth, entirely different in appearance from the parent stem, and in partial or dense shade in the woods the spines of some of the Echinocerei are usually finer and weaker than when the plants are growing in full sunlight. Young plants of some species of Opuntia, when growing in dense shade, may even have fine hairs instead of spines, but when these plants are moved out into the sunlight, normal spines soon begin to develop and the abnormal character disappears. In some species of the genera Lophocereus and Cephalocereus, changes in the spines occur with increasing age, but such changes take place in all the plants and are recognized as entirely normal. The discovery, however, of a new and strikingly different spine character in cactus plants which were growing under what may be considered completely normal conditions is sufficiently rare to be of interest. Such a variation may not be merely a response to environmental influences but may possibly be heritable.

Such a spine variation in *Echinocereus chloranthus* (Engelm.) Rumpl. was found in Brewster County, Texas, in the fall of 1932. These plants, instead of having the usual spine armament, were covered with fine, white hairs, which completely hid the body of the plant. Some plants, usually larger specimens, were also found on which both hairs and spines occurred. When this was the case, the hairs were located at the base of the plant, except in one specimen, which is shown in the center of Figure 12*A*, where a basal zone of hairs was succeeded by normal spines, above which occurred a second zone of hairs. While the hairy character appears to be associated with a juvenile stage of growth, since in most of the plants the hairs are succeeded by spines, some doubt is cast on this conjecture by the plant mentioned which bore a zone of hairs surmounting the spines. In most of the plants which bore both hairs and spines the transition took place at approximately the same position on the stem, but there was some variation in this regard. Most of the smaller sized plants, measuring from 3 to 4 centimeters in height, had no spines whatever, but a few of this size were found which were beginning to produce spines at their crowns, and one specimen, less than

3 centimeters tall, had well developed spines on the entire upper half of the stem. In some plants the transition from hairs to normal spines was gradual; the first radials above the zone of hairs being finer and more hair-like than those on the areoles higher up the stem. The plant at the center of Figure 12*A* also shows this character. In other cases the change was quite abrupt, as in the plant in Figure 12*B*, where the areoles immediately above the zone of hairs bear normal radial spines.

These plants varied in size from 23 to 40 millimeters in height and from 20 to 25 millimeters in diameter. The hairs measured from 8 to 15 millimeters in length. The hairs were quite fine and soft in texture and were densely set in the areoles, usually numbering about 40. They were more numerous than the spines. None of the plants which were collected has produced flowers, but there is little doubt that they belong to the species named. The series of plants appears definitely to connect the small, hairy ones with the specimens whose normal spines answer to the description of *Echinocereus chloranthus*, as given by various authors.

The same locality in western Texas was visited again in the fall of 1933, and more plants of this type were found. Among them were several tiny specimens, a centimeter or less in height and diameter, which were completely covered with hairs. No plants as small as these had been seen the year before, and it is probable that they were seedlings of the current year's growth. The appearance of the general vegetation of the region indicated that the season had been much drier than usual, and for that reason it is likely that these plants had made less than normal growth.

These plants were not growing in shade or under other conditions which might be expected to produce abnormal growth, but were found on a rocky hillside in full sunlight. They were associated with two other species of Echinocereus, an Escobaria, a Neomammillaria, and other species of cacti, all of which were normal in appearance. The writer has collected *Echinocereus chloranthus* and the closely related *E. viridiflorus* Engelm. in many places in western Texas, New Mexico and Colorado, but has never before seen plants with this hairy character. The form of *E. viridiflorus* which grows in the mountains of northern New Mexico and southern Colorado is frequently to be found in partial or complete shade, under which conditions some change in the characters of the spines might be looked for, but such plants are nearly always quite normal in appearance, and so far as known, no specimens with the character here described have been reported. If then, the hairy character in the plants described is strictly associated with a juvenile stage of growth, it is rather remarkable that it has not been hitherto reported in this species, which has a wide range and is frequently collected. Altogether, these plants present an interesting problem as to the reasons for their abnormal character, if such it is. It seems certain that the hairy character is associated with the juvenile stage of growth, but it also appears possible that it is heritable in plants of *E. chloranthus* in the particular locality where they were found. Most of the plants which were collected are now growing in cultivation, and if they survive and produce seed, new plants can be grown in comparison with seedlings from plants with normal spines, and perhaps an answer secured to the question as to whether the hairy character is inherited or is merely a response to some unknown factor of the environment. Should the former prove to be the case, it is possible that these plants deserve specific rank in the genus Echinocereus, or at least varietal distinction. Decision in this regard, however, must await further study of the plants, both in the wild state and in cultivation.

ABNORMALITIES OF THE HANDS AND FEET

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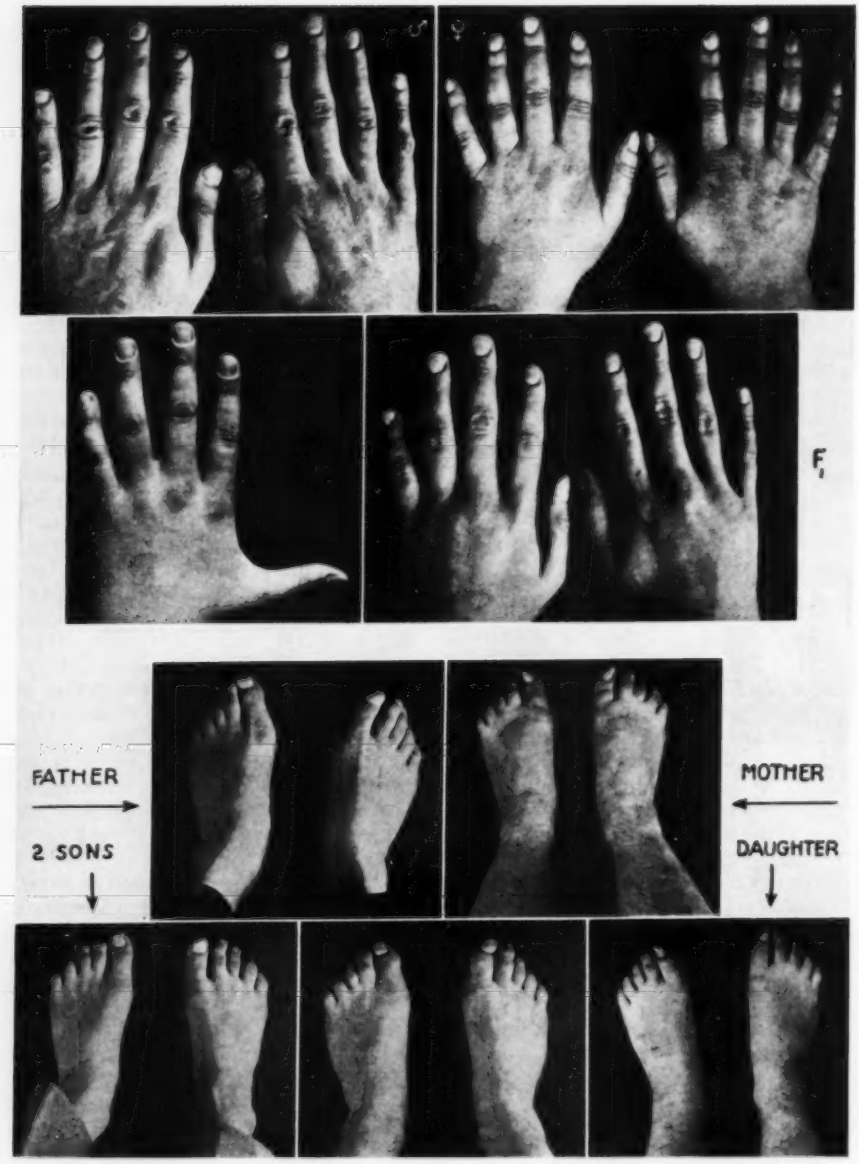
IN the present study it is proposed to consider some cases of anomalies of the hands and feet. The material on which these observations are based was collected in the course of the genetic research work carried on at the Anthropological Institute of the University of Vienna. The anomalies observed can be divided into two categories: serious deformities which occur very rarely such as syndactyly and slight anomalies which are much more common, such as webbing between the toes (zygodactyly, clinodactyly, etc.).

Syndactyly

Figure 15*A* shows a case of extreme syndactyly. In both hands the middle and ring fingers are completely grown together. They are coated with a common skin cover extending from the base of the fingers nearly to the joint between the first and second phalanges and hardly any division between the two fingers is noticeable up to this point. There is a shallow groove, or what may be called the indication of a division, extending in both directions from the joint; however, this appears only on the dorsal side. On the right hand the groove reaches as far as the nail-wall and it becomes much less marked toward the fingertips. On the left hand the divisional indication is present, though rather faintly defined, all along the second phalange. Between the second and third phalangeal joints it deepens in the same manner as between the first and second joints. The radial and ulnar borders of the second and third digits do not differ in shape from those of the remaining fingers. The transverse dorsal creases of the second and third phalangeal joints are very faintly marked. The function of the fingers in this particular case is in no way hindered by syndactyly and the individual in question exhibits great dexterity with his hands.

The nail regions of the hands show some interesting pecularities. On the right hand the two fingers are more distinctly grown together and appear to bear one single nail resting in a common nail-bed and split from the base to the nail tip. This, however, is not actually the case. Each finger has a nail of its own resting in a distinct nail-bed, the pecularity about them being that the edges of the nails are bent down at right angles along the line where they meet (the nail of the right finger on the radial side, that of the left finger on the ulnar side). However, they come so closely together as to appear to be one common nail. The same condition is found in the left hand, each of the two fingers which are grown together having a distinct nail separately embedded and in no way different from those of normal fingers.

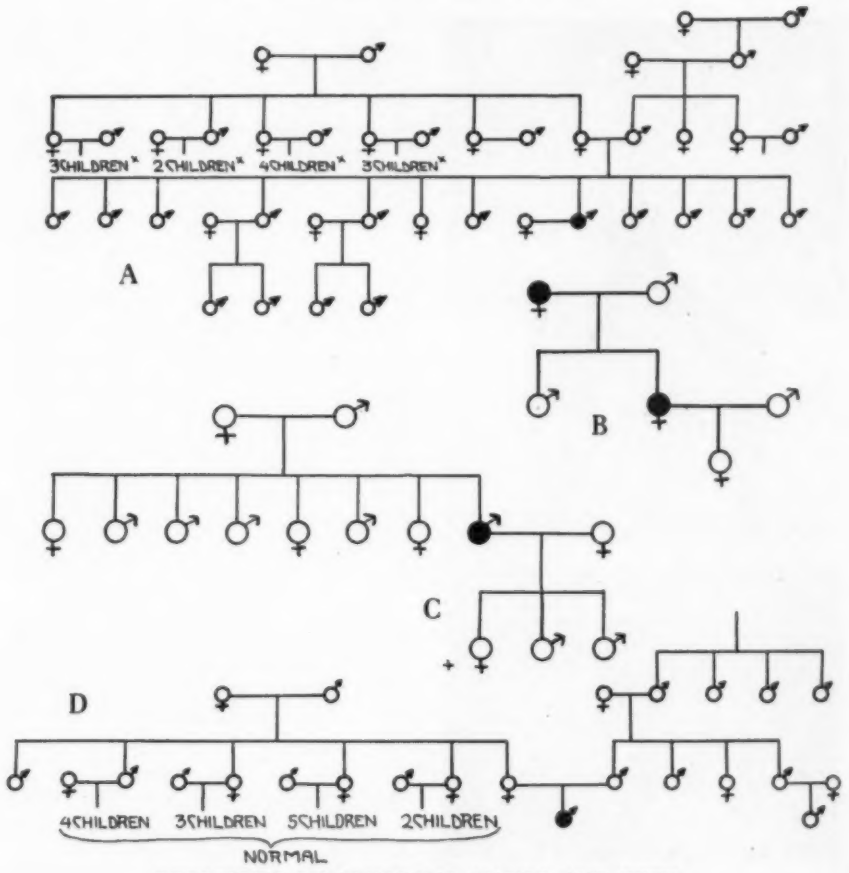
On superficial observation the anomaly of the right hand presents itself as one finger on which a median split is indicated whereas the left hand shows two distinct fingers connected by a bridge of skin. Moreover the second digit is longer than the third and the extreme sections of the finger tips are not grown together. On the right hand the second and third digits are of the same length and are completely welded together. These fingers are bent much more strongly ulnarwards than those of the left hand. The bend begins at the joint between the first and second phalanges and becomes more pronounced near the fingertips. It is also noteworthy that the first and fourth fingers are of exactly equal length. This was the only pair



PHOTOGRAPHIC "PEDIGREE CHARTS" OF NORMAL HANDS AND FEET

Figure 13

Above are shown the hands of a mother, father, and two views of the hands of their fourteen-year-old son. Note how the type of hand as a whole has been transmitted from father to son but with definite suggestions of maternal characteristics also inherited. The ability of the son to throw the thumb out of joint (as is shown at the left) is inherited from the father. Below is shown a similar family group of feet,—those of the mother, the father, and of three children, a daughter and two sons. In this case the mother and daughter show a striking resemblance as do the father and one of the sons. The eldest son (left) shows more of his mother's characteristics than does his brother.



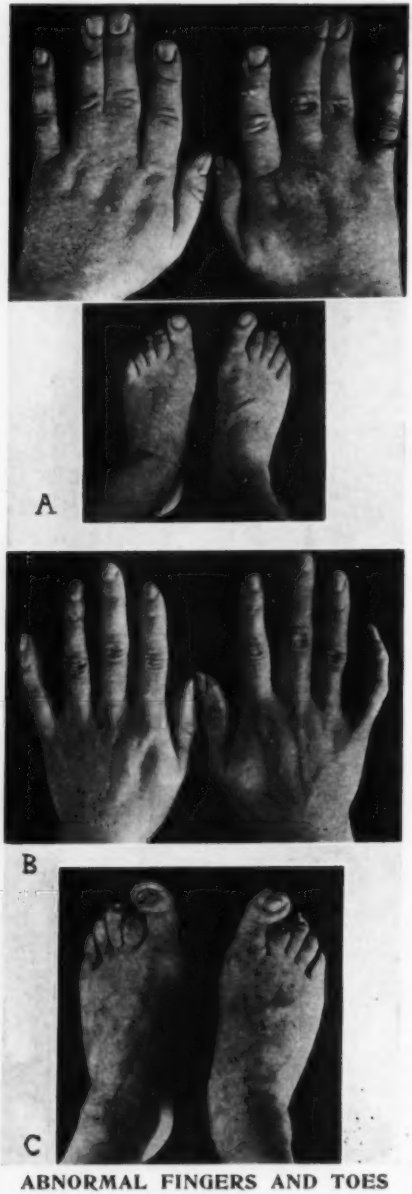
PEDIGREES OF ABNORMAL HANDS AND FEET

Figure 14

Many of the abnormalities reported in the literature of hands and feet are dominant characters. This is to be expected as the inheritance of a dominant character is much more readily demonstrated in human material than is a recessive. Some of the cases presented here are given as indications, either that such variations are sometimes non-genetic in origin or that they are conditioned by recessive or complementary genes. *A* shows the pedigree of the syndactyl individual shown in Figure 15*A*, demonstrating conclusively that the character is not a dominant if it is hereditary. *B* shows the case of camptodactyly (crooked little finger) shown in Figure 15*B*. In this case a dominant inheritance is suggested, as was reported by Heffner in this *Journal* in 1928. *C* shows the family pedigree of the hammer-toed individual shown in Figure 15*C*. It is believed in this case that the abnormality was due to faulty footwear, not to heredity. *D* is the pedigree of the individual with the short metacarpal bone of the left hand shown in Figure 16.

of hands found in the course of this extensive research having this peculiarity. (All photographs were taken upon a definite orientation of the hands to make comparisons possible.) Perhaps there is some connection between syndactyly and this peculiarity.

An X-ray photograph revealed two bony bridges between the terminal phalanges of the second and third digits of the right hand. On the left hand no such connection was visible.



ABNORMAL FINGERS AND TOES
Figure 15

A-Syndactylous hands and feet; *B* Crooked little fingers characteristic of mother and daughter; *C* "Hammer toe"—believed to be an environmental defect. See text and Figure 14 for details.

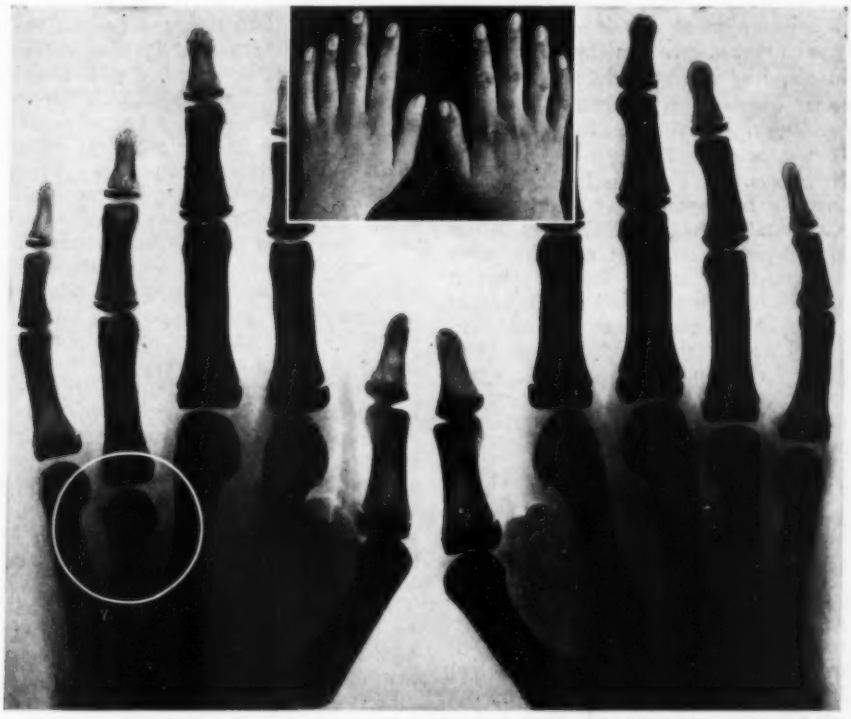
This condition undoubtedly is the cause of the bend of the two fingers at this point.

In anthropological literature it is often contended that syndactyly of the hands occurs jointly with syndactyly of the feet. The case here reported does not support this view. Figure 15*A* also shows a photograph of the feet of the person under consideration. It will be noted that the right second toe bends, first upwards, and then is bent down like a hammer owing to a stretching contraction of the metatarso-phalangeal joint and a flexing contraction of the interphalangeal joint. It must be emphasized that this deformity of the toe was observed soon after the birth of this individual.

The pedigree chart (Figure 14*A*) shows that during six generations, P—F_5, only one case of syndactyly occurred. Unfortunately it cannot be decided whether this is a sporadic occurrence of syndactyly or a case of mutation, the marriage of the person under consideration having been childless to date.

Camptodactyly

Camptodactyly (Figure 15*B*) or "crooked little finger" may occur either symmetrically or in only one hand. This defect is caused by joint contraction in the hands similar to that described above in connection with "hammer toe." The little finger invariably exhibits the strongest degree of this anomaly although the second and third digits are occasionally involved. In feet this deformity is found most frequently in the second toe (the one next to the big toe), and sometimes in the third and fourth toes. These anomalies may appear during prenatal (intrauterine) or postnatal (extrauterine) life, most of them, however, are hereditary, constituting, as a rule, a dominant mendelian trait, directly inherited. Inherited comptodactyly as well as "hammer toe" is supposed to be due to disturbances in the gene which is charged with controlling the normal position and flexibility of the inter-



A SHORT METACARPAL BONE

Figure 16

One metacarpal bone in the left hand is much shorter than the others. A similar variation was reported by Gillette (JOUR. HERED. 22: 489-90) as a dominant character, but in this family another explanation is indicated (See Figure 14*D*). In this case, if heredity is involved, the gene is recessive because no immediate members of the family show the peculiarity.

phalangeal joints. The pedigree chart shows that the mother of the woman examined also had the deformity. (Figure 14*B*.)

Brachymetapody

Figure 16 shows an external photograph and an X-ray of a case of brachymetapody. The third (ring) finger of the left hand hardly reaches to the second joint of the second finger. The considerably shortened body of the metacarpal bone is apparent. This anomaly is supposed to be due to a special genetic disposition which, however, does not appear to be very common as the phenomenon occurs only sporadically. In the majority of cases the third finger is affected. Figure 14*D* gives the pedigree and shows the sporadic occurrence of the defect.

An Environmental "Hammer Toe"

Above we have discussed cases of "hammer toe" in which the deformity is to be considered of a hereditary nature. The case illustrated in Figure 15*C*, while it resembles the hereditary cases, is probably to be explained as an acquired characteristic, inadequate footwear being the probable reason. It is true, however, that similar foot shape is to be observed not only in adults but in new-born infants. In all cases where these peculiarities are observed in the feet of mature indi-

viduals we must decide whether we have to deal with a hereditary or an acquired clinodactyly. In the case under discussion (Figure 15*C*) we see particularly broad and plump big-toes. Toes which are thicker in the terminal phalanges and bent fibularwards may possibly be regarded as symptoms of post natal pathological changes in the foot region. The foot exhibits other characteristics which indicate that it may have been modified by an unfortunate choice of footwear. The pedigree chart in this case (Figure 14*D*) proves that in three generations the anomaly was observed in only one individual. This fact supports the assumption of a post natally acquired anomaly, although it does not prove, of course, that recessive factors may not be involved.

Normal Hands and Feet

In addition to the conditions described above there are some characteristics which occur quite frequently in the population at large and which it might be well to mention in this connection. Figure 13 shows foot photographs of family 59/1-5 arranged in the form of a pedigree. Between the mother and daughter there are marked similarities in the contours of the feet, the shape of the toes, their respective positions, bends, the spacing between them, and finally the characteristics of the nails with longitudinal and transverse curvatures and the locality of the greatest breadth. There are points of great resemblance between the father, F 59/5, and the son, F 59/2. The hour-glass shaped toes, the bend of the second toe of the right foot reaching to the square and slightly arched nails are very similar. The degree of zygodactyly also is the same. The eldest son, F 59/3, shows characteristics intermediate between his father's and mother's but more of the father's characteristics appear. On hands such observations are more easily made than on feet, insomuch as it is rather difficult to prevail upon people to have their feet examined.

Figure 13 also shows the hands of a married couple. Their hands are of markedly different types. F 49/2 (mother) has rather short, broad hands with short fingers which are stout with ample soft parts and slightly tapering toward the tips. Her fan-shaped nails are to be contrasted with those of F 49/3 whose hands are long and rather narrow, the fingers having very long and narrow edges which run parallel except for the slight suggestion of hour-glass shape due to the thickening of interphalangeal joints. Their fourteen year old son (F 49/1) shows a striking resemblance to the father. His nails, on the other hand, are more like those of his mother. The slight webbing between the second and third digits and the marked double-jointedness of the thumb are characteristics also found in the father.

Conclusion

A more comprehensive study of this subject is in preparation. It is hoped that data on anomalies of hands and feet will prove useful in genetic biology and also have a practical application. Where we have inheritance of definite anomalies of hand and foot shape we may sometimes obtain information of great value in cases of disputed paternity.

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